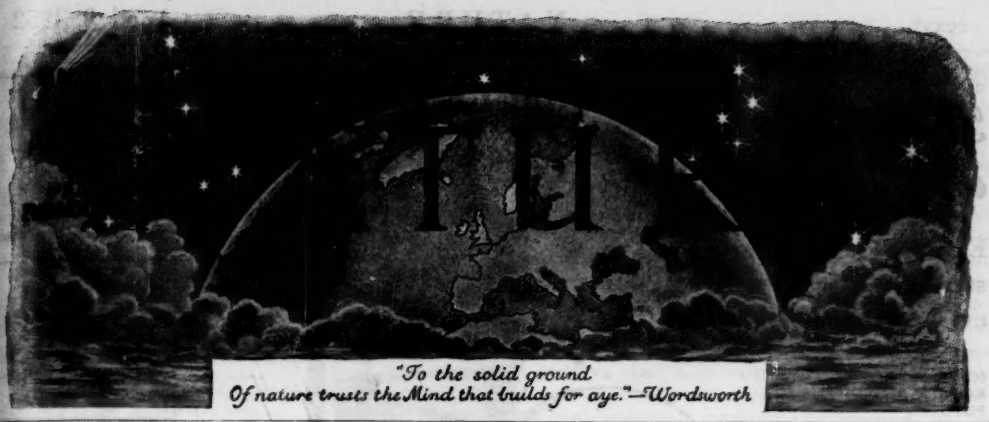


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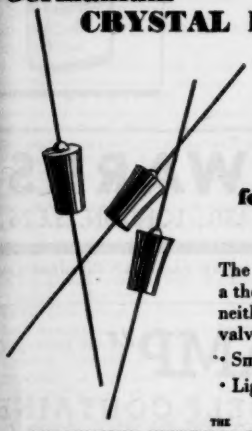

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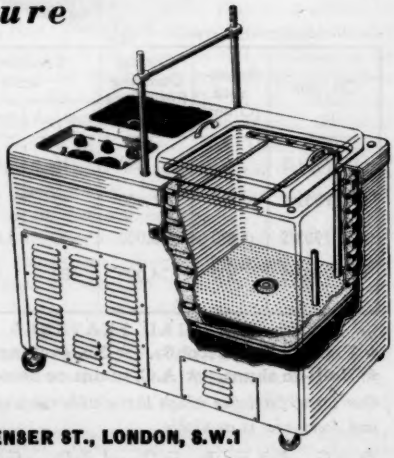

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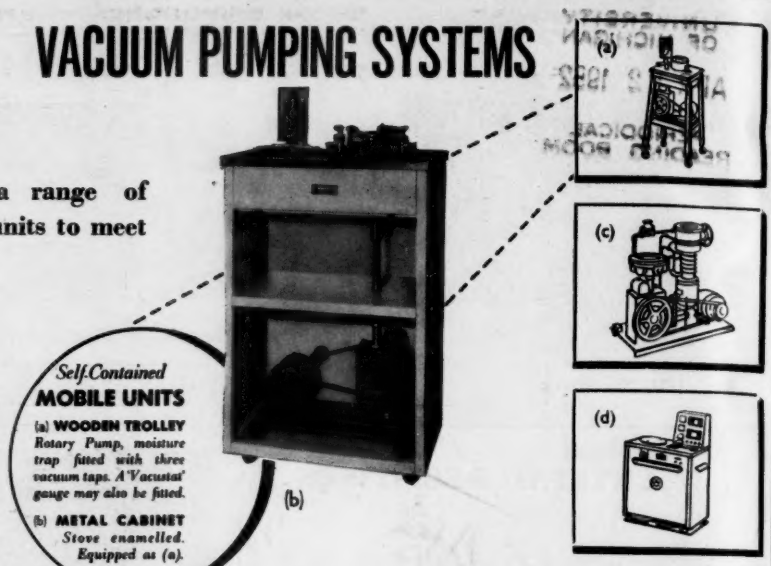


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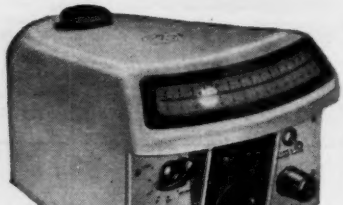

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# NATURE

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# INTERNATIONAL RELATIONS AS A UNIVERSITY DISCIPLINE

SINCE its establishment in 1928 as a "Conference of Institutions for the Scientific Study of International Relations", the International Studies Conference has given constant attention to ways of teaching international relations. Interest was evident in this question at the conference of representatives of universities held at Utrecht in August 1948 under the auspices of the United Nations Educational, Scientific and Cultural Organization, and a resolution adopted at that conference urged universities not already possessing chairs or departments, or otherwise providing for teaching and research on the subject of international relations, to do so or make other provision for such systematic teaching and research. This resolution helped to induce the International Studies Conference to convene a small international meeting at Windsor in March 1950 to discuss the desirability, or otherwise, of making more provision for the inclusion of international relations, as an independent discipline, in the curriculum of university students.

A brochure*, edited by Geoffrey L. Goodwin, which has now been published, includes a report of that meeting together with some notes on the provision made for the university teaching of international relations in Geneva and in Italy, in France, in the United States of America and in the United Kingdom. It gives a convenient picture of the way in which interest in the subject has developed from the realization that problems in international relations could profitably be studied, if not by scientific methods, at least with the objectivity with which the scientific worker approaches his problems, and the more important differing points of view are indicated, so far as they were expressed at the Windsor meeting. The full extent of the controversy about the nature of international relations and its claims to be regarded as an international discipline is perhaps scarcely revealed in this brochure and, apart from its delineation of the present position of teaching in this field, the brochure is most useful for the text of the paper on international relations as an academic discipline which was prepared for discussion at the Conference by Prof. C. A. W. Manning, Montague Burton professor of international relations in the University of London. Mr. Goodwin's own paper on the teaching of international relations in the United Kingdom also includes a good account of present ideas on the subject.

The brochure at least makes it plain why the controversy exists, and there is little reason shown to suggest that controversy is likely to come to an early end. The attitude of most of the protagonists is often reasonable, and few are disposed to claim more than that the study of international relations and of those branches of the humanities and of the social sciences in which it is rooted should be pursued

* The University Teaching of International Relations. Edited by Geoffrey L. Goodwin. (International Studies Conference.) Pp. 126. (Oxford: B. H. Blackwell; Paris: Presses universitaires de France, 1951.) 8s. 6d. net.

in the spirit of science, rather than that international relations should be described as a science in itself. Nevertheless, the arguments for regarding international relations as an independent academic discipline are sometimes a little naïve, and do credit to the altruism rather than the judgment of the protagonists. Mr. Goodwin, for example, regards the subject as akin to history as much as it is to sociology and involving a sociological approach. But this does not deter him from endorsing such views as that the teaching of international relations could accustom the student to making decisions in problematic situations, and train him to exercise the sort of appreciation or intuition which a soldier or a statesman has to exercise in time of crisis.

It is this sort of fallacy that makes the reading of the brochure so depressing. Those who hold such views seem to have sadly confused ideas as to the purpose or functions of a university, just as their claim that international relations is a new subject ignores the extent to which for centuries problems of war and peace and the foreign policy of States have occupied the minds of philosophers and historians in the universities of the West. The weakness of the argument set forth in this brochure is that it does less than justice to this fact, and that it fails to distinguish between what is expected of the statesman who must act, and of the scholar called to study, to reflect and to teach within the university.

For the first, the attempt to justify international relations as an academic discipline because it should help to overcome the fragmentation of knowledge may in part be responsible. The argument does not show how or why the study or teaching of international relations could assist, and a clearer idea of the functions of a university might well have prevented the argument being advanced. At least there would then have been some adequate discussion of the characteristics which should mark any new subject that has claims to be admitted to university teaching. As it is, the three conditions stipulated by Prof. G. B. Jeffery in his Eddington Memorial Lecture are ignored. Although his lecture on the unity of knowledge urged that many students will receive no help at all in facing some of the fundamental moral questions of our time except within the university, Prof. Jeffery appears to dispose of the claims of international relations either to remedy fragmentation or to constitute an adequate university discipline.

It is as well, however, that we should have this further reminder of the pressing importance of fresh thought about the purpose and functions of a university, to enable us to reach sound decisions regarding the nature and extent of the studies which it should provide. That is enforced on us by the present financial stringency, as well as by the necessity of considering more closely the selection of students, and especially in relation to the training of men for taking a responsible part in the affairs of the nation. Little evidence was advanced in the discussion at Windsor to show that the teaching of international relations as such will contribute more towards giving the student a fuller understanding of the world in which he or she is to live than the reflective and imaginative teaching of those subjects, such as history and philosophy, which have long since established their claims as independent disciplines. One is reminded rather of Sir Walter Moberly's plea for more thinking about the importance of things already known. Books like Fisher's "History of Europe", Trevelyan's "English Social History" and Whitehead's "Science and the Modern World" do, as Sir Walter points out, throw new light on the significance and correlations of known facts, and this is an important contribution to the growth of understanding. From such works might well come a much deeper understanding than from anything which the establishment of faculties of international relations could at present hope to contribute. But, however firmly we may argue that such a step is premature or undesirable—or even impracticable at the present time—the subject will none the less continue to be studied and taught as it has been for centuries. The name may be unimportant, but the vantage-point is not.

International relations will be most fruitfully studied and will influence international practice most effectively when the subject is approached by divers ways and from many points of view. On practical grounds alone such an institution as the College of Europe, now in the full swing of its second year, and manifestly compelling attention to the very basis of European civilization, has stronger claims for support, as indeed Mr. Robert Birley argued in his Reith Lectures in 1949. The implementation of such a programme of international university collaboration and interchange of students and teachers as was visualized in the report of the British Association's Committee on Post-war University Education eight years ago, and afterwards in one from the Association of University Teachers on the international functions of a university, or again in the report on university reform in Germany, might well do far more to achieve the professed objective of those who participated in the Windsor discussions than any of the arrangements suggested in the agreed statement issued by the meeting.

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## OPERATIONAL RESEARCH

### Methods of Operations Research

By Prof. Philip M. Morse and Prof. George E. Kimball. First edition revised. Pp. vii+158. (New York: Technology Press of Massachusetts Institute of Technology and John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 32*s.* net.

THERE will, no doubt, continue to be discussions about what operational research really is, and whether it is quite a respectable occupation for men of intelligence and scientific ability. This book will allow those discussions to contain some of the facts of military operational research.

The history of the book has determined its form and content. Profs. P. M. Morse and G. E. Kimball were both members, during the Second World War, of the Operations Evaluation Group of the United States Navy. At the end of the War, a collection of

'summary reports' of the work of the National Defense Research Committee was magnificently produced in the United States, and this book, in its original classified form, was volume 2*A* of one of the series. The mysterious references, dotted about the book, to "volume 2*B* of the present series", arise because Chapters 2–7 are reprinted from the original type-setting.

The book is therefore mainly about operational research in war—and, within that, predominantly about the war at sea. But it does indicate the wide sweep of military operational research, particularly when it is remembered that there are many interesting examples which may not yet be published. The authors have tried, in Chapter 1, to add a few civil and industrial examples, which are, unfortunately, mainly descriptive and a little thin. Perhaps a comparable body of civil experience does not exist, or is only slowly being published; or it may be that commercial secrecy is greater than military security. A considerable body of operational research is being done in civil and industrial organizations in Great Britain and in the United States, and as it is published it may be possible for future authors to produce a better-balanced book.

The examples of military operational research are well chosen and very well presented. The civil worker will have to search for analogy either of problem or of method. Chapter 2 gives a very good summary of probability theory as it is found useful in this work: it is somewhat unorthodox but strictly utilitarian. There are some very interesting developments of Lanchester's equations in Chapter 4, together with some of his original material which is not easy to find elsewhere.

The last chapter is an unsuccessful attempt to generalize about organization from the particular experience of the United States Navy. No operational research man worth his salt will, these days, continue to work if he does not believe that his results reach the right people, who are prepared to be influenced by them; and organizations are so different that that is really the only rule.

There is, in Great Britain, a lamentable tendency to identify operational research and statistical methods. This book will do something, but perhaps not enough, to correct that tendency. It should be read by all who wish to argue whether it is or is not a sensible thing to use scientific method as one of the tools for the shaping of policy. It is to be hoped that other, equally well-informed, publications will follow.

E. C. WILLIAMS

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## RECORDS OF ZOOLOGICAL LITERATURE, 1864-1948

### The Zoological Record

Vol. 85: Being the Records of Zoological Literature relating chiefly to the Year 1948. Edited by Malcolm Smith. Pp. vi+1262. (London: Zoological Society of London, 1951.) £4.

THE eighty-fifth volume of the "Zoological Record", which indexes the literature chiefly of the year 1948, continues an unbroken series of this imposing bibliography since the first volume appeared in 1865. This continuity is indeed remarkable when we call to mind the vicissitudes that have accompanied the course of such important and seemingly indispensable works as the "International Catalogue of Scientific Literature", the cards issued by the Concilium Bibliographicum, and, more recently, the "Surgeon-General's Catalogue". The "Zoological Record", likewise, has had its ups and downs; and round about 1900, when the "International Catalogue" was covering the same ground as the "Record" and subscribers were falling away from the latter, the financial position of the "Record" was indeed precarious. A compromise was eventually reached by which the "International Catalogue" and the Zoological Society were able to co-operate in the production of the "Record". With the coming of the First World War, the Zoological Society was able to resume issuing the "Record" as its own publication, and still does so, though other individuals and institutions support the venture, and donations amounted to more than £1,400 in 1948.

The Second World War caused further interruptions and dislocations; but it is something to be wondered at and to be grateful for that the "Record" is now only about two years behind in its indexing. Every effort is clearly being made to bring out each volume less than twelve months after the end of the year to which it refers. This was stressed right at the start, and is obviously of great importance in modern scientific work. In this connexion it should be remembered that the separate sections are usually available some considerable time before the complete volume. This is a great advantage for individual workers and specialists who may not require, and who probably have little shelf-space for, the complete bound volume. These separate sections can be quickly consulted, even though a score or more parts may have to be perused at any one time.

As it appears that there are still some zoologists who are not familiar with the "Zoological Record", it may be of interest to recall that the first volume, for 1864, published under the editorship of Dr. Albert Günther in 1865, was a comparatively modest book of 634 pages, containing fourteen sections. The Cœlenterata and the Protozoa had to be deferred to the second volume, as the gentleman to whom this portion had been entrusted had, in the words of the preface, "failed to keep his engagement". The 1948 volume runs to nineteen sections and 1,262 pages. This increase is even more significant when we recall that the style of presentation in the first volume was entirely different from the concise bibliography we know to-day. In 1864 the recorder was to inform the student as fully as possible what he might expect to find in a work or memoir, and the recorder might add, and rarely refrained from doing so, critical remarks of his own, sometimes of a somewhat severe character. Short diagnoses were also given of new genera, and the critical animadversions were often expanded into discursive essays of considerable length. The recorders, however, did not themselves escape unscathed, for a review of the work in the *Athenæum* of November 25, 1865, contains the following paragraph: "There may be some discrepancy in the ability with which the abstracts of the various subjects are worked out, and in the manner in which those who are themselves authors refer to their works. It is perhaps difficult for men wholly to avoid self-glorification, and the appearance of their names in 'small capitals' is to some a source of great satisfaction".

The early volumes of the "Record" are something more than indexes; they are readable and stimulating, but when we find that there are nearly twelve

thousand references in the 1948 volume, and that the Insecta section alone runs to 350 pages, it is evident that the subjective commentary had soon to give way to an austere title-entry with adequate bibliographical details. Modern developments are not ignored, moreover; for example, the systematic index to the Mammalia section is now arranged according to Simpson's 1945 classification. The rather stout but well-printed volume under review, with its three main divisions, under each class, of titles, subject index and systematic index, is a scientific bibliography of which British zoologists may justly be proud, and which merits support by all workers in this wide field.

How is the work compiled? What degree of completeness is achieved? These pertinent questions may well be asked in view of the vast amount of literature that might be expected to come under review. The recorders obtain the raw material of their product mostly from among the resources of certain important libraries, and also from the copies of books and reprints which individual authors send to the editor. Thus much depends on the authors themselves, who endeavour to see to it that a copy of their work reaches the editor, or a central library of the subject, and much more upon the successful efforts of the libraries principally concerned in obtaining the maximum amount of relevant material. Gaps in the "Record" there surely are: much literature from the 'Iron Curtain' countries appears to be lacking; in libraries some series of periodicals which were interrupted by the War may never be entirely completed; some important zoological material is still published in obscure and inappropriate journals and in unfamiliar languages; some popular and 'borderline' materials may fail to be recorded for one reason or another, and it can be seen that in all this the responsibility of the libraries is great. It is to be hoped that the libraries concerned will not be hampered in the future by lack of funds or of adequate staff in the essential work of building up the collections of literature so admirably indexed by the "Zoological Record". None the less, the zoologist may feel confident that few, if any, of the really important contributions to his study are missed by the "Record"; and when one reflects that the work seeks to assist not only systematic zoologists, but also palæontologists, comparative anatomists and physiologists, to mention only three types of investigator, it can be realized that the standard of comprehensiveness is a high one indeed.

Zoologists can congratulate themselves that in the "Zoological Record" they have a well-ordered, carefully indexed muster of the year's literature in their subject, the result of a magisterially edited co-operative effort by the libraries which acquire and make available the printed material, and the specialist recorders who so skilfully and industriously arrange and index it.

The needs of the future may call for new developments. Some form of cumulative volume may be considered desirable—it may even be that the "Record" of the future will be on micro-cards—but whatever the form of the bibliography, it seems clear that no zoologist who seeks to produce work of any lasting value can afford to dispense with it. Fortunately there seems to be a growing bibliographical consciousness among zoologists which should provide the necessary skill, energy and financial support to ensure the continued production of this admirable work.

A. C. Townsend

# BIOLOGY OF THE ALGÆ

## Manual of Phycology

An Introduction to the Algæ and their Biology. Edited by Gilbert M. Smith. (Plant Science Books, Vol. 27.) Pp. xii+375. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1951.) 7.50 dollars.

THROUGH the years there has been considerable variation in the limitations of the term algæ, some of the lower groups of flagellates being treated by the botanist or protozoologist, according to the particular views of the worker. In the "Manual of Phycology", however, a short history of the subject is followed by an account of individual major groups which include the Dinoflagellates, or Pyrrophyta as they are called, as well as the more generally accepted members of the class. The volume is edited by Gilbert M. Smith, of Stanford University, and each chapter has been contributed by a specialist.

The book opens with a chapter on the history of phycology by G. W. Prescott, of Michigan. His task was no doubt an extremely difficult one; but it is surprising that no mention is made of the work of A. H. Church, of Oxford, whose book "Thallasiophyta and the Subaerial Transmigration" gave great stimulus to algological work and thought in Britain at the beginning of this century. The second chapter is written by the editor and gives an outline classification of the algæ, with the characteristics of their main divisions. Then follow chapters on the main groups: Chlorophyta by M. O. P. Iyengar (Madras), Euglenophyta by T. L. Jahn (California), Chrysophyta by F. E. Fritsch (London), Pyrrophyta by H. W. Graham (Florida), Phæophyta by G. F. Papenfuss (California), Cyanophyta by Francis Drouet (Illinois) and Rhodophyta by Kathleen M. Drew (Manchester). The authors vary in the emphasis they give to different aspects of the subject; but in every case the structure, reproduction and classification of the groups are discussed.

Ecological and physiological problems have not been taken into account in these general treatises; but these are followed by a series of chapters dealing with algæ in general, from different points of view. A chapter has been devoted to fossil algæ by J. Harlan Johnson (Colorado). Then follows an interesting general treatment of the cytology and sexuality of the algæ by the editor and H. H. Strain (California) respectively, and a chapter on physiology and biochemistry by L. R. Blinks (California).

The ecological section is dealt with in two parts, the freshwater algæ by L. H. Tiffany (Illinois) and the marine by Jean Feldmann (Paris). This latter is a particularly lucid and fresh outline account of our present knowledge of the subject, with a discussion of marine vegetation in different parts of the world.

The biological significance of the phytoplankton is described by Bostwick H. Ketchum (Woods Hole), and two appendixes give consideration to the methods of cultivation of the algæ and to microtechnique. These latter have been contributed by E. G. Pringsheim (Cambridge) and D. A. Johansen (California) respectively.

There is an index, the book is well though not profusely illustrated, and excellent bibliographies conclude each chapter. The presentation of the material does not follow the lines of standard textbooks—it has an originality of form which arises, no

doubt, from the fact that specialists have contributed material about which they are particularly enthusiastic. In the aggregate, that has produced a volume which will be of great value both to the student of phycology and to those whose interests in the subject are of a more general character. LILY NEWTON

## AN AMERICAN TEXT-BOOK OF ZOOLOGY

### Anatomy of the Chordates

By Prof. Charles K. Weichert. (McGraw-Hill Publications in the Zoological Sciences.) Pp. vii+921. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 68*s*.

PROF. C. K. WEICHERT is professor of zoology in the University of Cincinnati, Ohio, and this book is written primarily for American students 'majoring' in zoology. Only four representative animals are dealt with in detail: *Petromyzon*, a dogfish, the salamander 'mud puppy' (*Necturus maculosus*), and the cat. The consideration of the four selected types occupies fewer than a hundred and fifty of the total of nine hundred-odd pages of letterpress. This disproportionate lack of emphasis on gross anatomy may prove a little horrifying to those who have been nurtured on the broader morphological fare that characterizes the zoology courses in British universities. But if we deprecate that so much has been left out, we cannot but admire much of the material that Prof. Weichert has been at such pains carefully to collate, correlate and put in.

The book is divided into three principal sections. Part 1 is devoted to classification, natural history and development. Part 3 deals with the four animals mentioned above. The second part of the volume deals extensively with the organ systems of vertebrates, and is probably the finest account of its kind available in any text-book of zoology. The integumentary, digestive, respiratory, circulatory, endocrine, reproductive and other systems—and the receptor organs—are all treated from a comparative point of view, and there is a pleasing emphasis on function, as well as structure, throughout the series. Numerous excellent, clearly labelled diagrams illustrate the text.

Another admirable feature of the volume is its passing treatment of the biology of man wherever appropriate. It has to be confessed that many students graduate with an honours degree in zoology yet still possess only the sketchiest knowledge of the biology of themselves. Certainly this charge could not be laid to Prof. Weichert's students; in fact, the inclusion of the diagram illustrating McBurney's point (for the location of the human appendix) and one or two other minor matters could lead, perhaps, to the conclusion that he has carried his zeal in this direction a trifle too far. A possibly unfortunate trace of provincialism, too, occurs here and there. For example, in a text unburdened by references to original research we read that "the experiments of Prof. Carl Moore and his co-workers have definitely established that the scrotum serves as a temperature regulator". This being so, it would have been gracious also to have mentioned the name of the distinguished foreigner whose pioneer work first made it clear that such was the case and provided a basis for all subsequent work on the subject.

"Anatomy of the Chordates" should prove most valuable for collateral reading in Great Britain, for it contains much information that is not usually given in British text-books of zoology. In production, the book epitomizes the high standard that we have come to expect from the McGraw-Hill Company. It is a pity that the high price of North American publications (68*s*. in this case) will probably preclude most British students from personal ownership.

A. J. MARSHALL

## POLYZOA AND THE AGE OF THE CRAGS

### The Pliocene Bryozoa of the Low Countries and their Bearing on the Marine Stratigraphy of the North Sea Region

By Robert Lagaaij. Pp. 233+26 plates. (Maastricht: Uitgevers-Mij Ernest Van Aelst, 1952.)

THIS work originated in a study of the Bryozoa (Polyzoa) obtained from borings in Holland; but it was extended in an attempt to use them for correlating certain horizons of the Pliocene in the North Sea area. It consequently also involved the investigation of British and Belgian material of similar age, that from England being from the Coralline and Waltonian Crags of Suffolk and Essex. For such a stratigraphical correlation and discussion to be of any value, the identifications of the species must be critically made. Dr. Robert Lagaaij has therefore re-examined much of the material, now in the British Museum (Natural History), described in 1859 by G. Busk in his classic "Monograph of the Fossil Polyzoa of the Crag", and in addition he has made extensive use for purposes of comparison of the magnificent collection of Recent Polyzoa there. Thus the systematics have been very carefully worked out, and zoologists and palæontologists studying the group will find much of value to them in the results. Both Cheilostomata and Cyclostomata are dealt with, the former contributing the major part of the fauna. The numerous photographs and admirable text-figure drawings fully illustrate the text.

For British palæontologists the Polyzoan fauna described from the Waltonian is of some interest, though it has to be searched for in the section on systematics. For that horizon the author has confined his attention to the encrusting forms (with one exception) so as to be sure he was considering indigenous specimens and not those derived from the Coralline Crag.

With the systematics securely based, the stratigraphical results deduced from an analysis of the Polyzoan faunas can be accepted with confidence. They concern particularly the Scaldisian–Poederlian deposits of Belgium and Holland and the Coralline and Waltonian Crags of East Anglia, but also deal with the Diestian. The fauna of the Lower Diestian is held to be older than that of the Coralline Crag and to bear strong Miocene affinities. The Scaldisian of Antwerp and the Netherlands, with a high percentage of Polyzoa in common with the Gedgravian (Coralline Crag), can clearly be correlated with the last named. The author supports the suggestion that the Poederlian is a transgressive facies of the Lower Amstelian, and correlates it with the Waltonian of Essex, in which the first 'colder' Polyzoa appear: these are taken as the equivalents of the Calabrian

of Italy and as the first Pleistocene deposits. These are conclusions that conflict with long-accepted ideas. J. Reid Moir had already challenged them in part in 1924, and recent work, based on a more critical determination of the fossil species, tends to show that the earlier correlations need revision. Thus, Dr. D. Wirtz's conclusions from his studies of the Mollusca of the Limonitsandstein of Sylt are in accord with those of Dr. Lagaaij. It is clear that Dr. Lagaaij has made an important contribution to the classification of the Plio-Pleistocene deposits by his detailed investigation of a much neglected group of fossils.

## BOATS THROUGHOUT THE AGES

### Boats and Boatmen

By T. C. Lethbridge. (The Past in the Present Series.) Pp. viii+199+4 plates. (London: Thames and Hudson, Ltd., 1952.) 15*s*. net.

MR. T. C. LETHBRIDGE brings to the writing of this book several special qualifications. Boats and their build and rigging have been his passion all his life, and what he does not know about their construction is not worth knowing. He is in the line of succession of H. H. Brindley and James Hornell. Himself an experienced sailor and explorer, he is also well known as an archæologist who speaks with particular authority on Anglo-Saxon times in eastern England—the result of years of excavation. To these specialist qualifications he adds the ability to make accurate thumbnail sketches in pen-and-ink showing clearly the differences in build and rig between the numerous kinds of craft he describes. It need scarcely be said, then, that "Boats and Boatmen" is a work full of interesting facts, well presented and well illustrated.

There are many theories adumbrated and suggestions thrown out. All of them are plausible, and doubtless a proportion of them are true. It is argued, for example, that experiments in construction took place in estuaries rather than elsewhere: it was not safe to play about with the received canons of boat-building if you were going to sail far out into the deep blue sea. Again, it is suggested that no ideas grew in the minds of the actual boatmen themselves. New possibilities developed in the imaginations of the directors and owners. As Lord Raglan once remarked apropos of anthropological matters, "the peasant never invented anything, the inventor was the man who set the peasant to work". It has been the warrior directing the fleet who will have been always experimenting to produce larger and faster craft. In the same way, it will have been the merchant and the fishmonger (rather than the fisherman) who have been trying out new ideas for the past two thousand years. Lethbridge also throws out many suggestions in the chapter on superstition and ritual, both as to the meaning of such signs as the oculus and the figurehead, and their regions of origin. I am not competent to pronounce in this field, and every student of such matters seems to have his own pet theory. But Lethbridge's ideas appear to the layman to be perfectly reasonable. I suppose he will be most criticized in his disparagement of the inventive genius of the northern folk, especially of the Vikings. He allows them clinker-building; but suggests that most of the other developments seen in their craft were derived from the Mediterranean.

There are chapters on fishing and fishermen; superstition and ritual; the origin and development of boats in the West; how boats are propelled; the influence on boat design of beaches and estuaries. As has been said, each chapter is profusely illustrated with sketches. There is one big omission: the book lacks a glossary of technical terms arranged alphabetically. On p. 131 we are told a boat has heavy "quests". Alas, I do not really know what a quest is. A valiant attempt has been made in the early chapters to make the nautical jargon intelligible to the layman; but a glossary of terms would save much trouble and should be included in the second edition—which will certainly be called for.

M. C. Burkitt

## DIFFERENTIAL GEOMETRY OF CURVES AND SURFACES

### Lectures on Classical Differential Geometry

By Prof. Dirk J. Struik. Pp. viii+221. (Cambridge, Mass.: Addison-Wesley Press, Inc., 1950.) 6 dollars.

THIS book is based on a course given by Prof. D. J. Struik at the Massachusetts Institute of Technology. It gives a clear and attractive account of the differential geometry of curves and surfaces. A distinctive feature is the large number of diagrams, supplemented by a few photographs of models of surfaces. Another excellent feature is the abundance of historical and bibliographical notes, which not only stimulate interest, but also help students to refer to the original sources.

Chapter 1 explains vector notation, in the form used by Gibbs, and applies this to the properties of curves, their tangents, osculating planes, curvature, torsion, evolutes and involutes. Chapter 2 deals with the elementary theory of surfaces and their tangent planes, normals, and asymptotic and curvature lines. It includes an account of the first and second fundamental forms, the indicatrix, conjugate directions, and triply orthogonal systems of surfaces. Chapter 3 deals with the fundamental equations from the Gaussian point of view, including the equations of Gauss, Weingarten and Codazzi. The fundamental existence theorem of Bonnet is enunciated and explained; but the general proof has been omitted as requiring too much knowledge of partial differential equations. Chapter 4, entitled geometry on a surface, opens with geodesics, geodesic curvature and geodesic co-ordinates. It then proceeds to the discussion of surfaces of constant curvature, non-Euclidean geometry, and the Gauss–Bonnet theorem concerning the integral of the geodesic curvature. Chapter 5 deals with some special subjects, including envelopes, conformal mapping, isometric and geodesic mapping, minimal and ruled surfaces, and the imaginary isotropic surfaces.

There is a large number of problems. Those in the text are easy, though of geometrical importance. A much harder set of twenty is given at the end of the book. These are really important theorems, and the student who finds them difficult can turn to the references given. The book concludes with answers to problems and hints for their solution, and with an index.

H. T. H. Piaggio

# THUNDERBOLTS: THE ELECTRIC PHENOMENA OF THUNDERSTORMS

A GEOPHYSICAL Discussion at the Royal Astronomical Society, held on January 25, was devoted to the subject of thunderbolts. The choice of date was, unintentionally, felicitous because, as the Secretary of the Society mentioned, January 25 is the recognized anniversary of the turning point in the life of St. Paul, when "suddenly there shined round about him a light from heaven; And he fell to the earth . . .", blinded by the shock.

In introductory remarks, Mr. E. Gold (chairman) said that, in ancient and classical times, the word translated thunderbolt was generally used for ordinary lightning discharge, "begotten from thick clouds piled on high". A reference in Abelard's letter to a friend—"the high summits call the thunderbolt"—implies that also in medieval times the thunderbolt was ordinary lightning. But nowadays the word thunderbolt often implies an unusual phenomenon such as ball lightning. The discussion, he said, would be concerned mainly with the fundamental physics of thunderstorms. A knowledge of the fundamental physics, in which many advances have been made in recent years, is essential not only for the understanding of ordinary lightning but also for the elucidation of certain electrical phenomena of thunderstorms which, according to the evidence of credible witnesses, were neither ordinary lightning nor imaginary apparitions.

Dr. T. W. Wormell spoke of the light thrown by recent investigations at Cambridge on the mechanism of the lightning discharge and on the processes causing the electrification of the clouds. Records at Cambridge of the electric field near the earth's surface during lightning flashes at distances between 20 km. and 100 km. show that in much earlier work the importance of the slower parts of the discharge has not been adequately appreciated. In these recent records special care has been taken to ensure that quite slow variations of the field are faithfully delineated, and this has furnished direct information of the vertical movement of the electric charge during a discharge. In a typical change of field, the slow variation lasts for 0·3 sec. or more; but it is interrupted in some cases by much more rapid changes with a duration of the order of 0·001 sec. The slow variation is sometimes intermittent, as in the luminous steps photographed by Schonland and his colleagues, but the phenomenon is comparatively rare in the Cambridge records and is usually confined to quite brief portions of the slow change of field.

The presence on the record of major rapid portions of the field-change indicates a discharge to earth. An analysis of 1,500 discharges shows that 37 per cent of all flashes reached the earth, 32 per cent bringing down negative charge only, 3 per cent positive charge only and 2 per cent charges of both signs. The other predominant type of discharge, 45 per cent of all flashes, is within the cloud and takes negative charge upwards.

The initial slow variation of field on the occasions of discharge of negative electricity to earth has a mean duration of the order of 0·1 sec., a figure greatly in excess of previous estimates. Slow variations may occur between the subsequent rapid variations; but in about three-quarters of the examples these slow variations are very slight, implying that the regions successively discharged to earth were all at about the same height. In the remaining examples, the records of change of field indicate that the heights of the regions discharged increase at successive steps.

Schonland in 1938 suggested that successive discharges originated in neighbouring 'cells' in the cloud, all with approximately the same base-level, a conception fitting three-quarters of the Cambridge records. But this conception of separate cells was abandoned by Schonland in 1951, because an examination by him and Malan of the field-changes in South African storms showed that, in these storms, successive strokes *normally* came from regions "which are progressively higher and higher within the cloud".

This difference in predominant character between the storms in England and those in the plateau region of South Africa emphasizes the need for similar investigations elsewhere, especially in equatorial sea-level areas and in high-level plateau regions of the temperate zone.

The normal negative potential gradient beneath a thundercloud is often interrupted by periods of positive gradient, usually associated with very heavy rain. Mr. I. C. Browne, at Cambridge, using a radar vertical beam, wave-length 3 cm., finds intense echoes from quite a low height on such occasions, and the intensity increases steeply with decreasing height. These observations appear to support the Simpson–Scrase explanation of the positive charge in the base of thunderclouds as due to the breaking of drops in an ascending current. But there are difficulties in reconciling this interpretation of the radar results with the observed rate of rainfall. Further, the process appears inadequate to produce a large enough positive charge.

Dr. F. J. Scrase spoke of the distribution and generation of electricity in the cloud and of the essential differences in electric character between the shower-cloud and the thunderstorm-cloud. The first direct information about the distribution of electricity in the thundercloud was obtained just before the Second World War by balloon soundings inside the clouds at Kew. These showed a bi-polar structure, with positive electricity in the upper half of the cloud and negative in the lower half. They also disclosed the unexpected existence of a pocket of positive charge embedded in the lower part of the negative half of the cloud. This was so surprising that there were, not unnaturally, doubts about its reality. These doubts have now been resolved. The existence of this positive charge has been confirmed by aircraft observations in cloud in the United States and by observations in cloud on the summit of the Zugspitz (10,000 ft.) in Europe. It seems now practically certain that this pocket of positive charge in the base of the cloud is essential for the initiation of a discharge. This requires a very strong electric field, and these two closely placed positive and negative charges can, as pointed out by Whipple in 1938, produce the necessary intense local fields. The soundings at Kew indicated that the intense fields did occur only in limited regions, because fields exceeding 100 V./cm. were found in only 15 per cent

of the soundings. There could not, therefore, have been large horizontal sheets of positive and negative electricity with intervening fields approaching the discharge value of 10,000 V./cm. as a general feature of thunderclouds. Ross Gunn, from aircraft measurements, found average maximum fields about 1,300 V./cm. (highest value 3,000 V./cm.), and considers that such high fields are more widespread than the Kew soundings indicate. Although the Kew apparatus showed whether the field was less or greater than 100 V./cm., it was not designed to record the actual value of the field, and the maximum values on those occasions when the apparatus showed a field greater than 100 V./cm. may well have been 1,000 V./cm. or even the discharge value of 10,000 V./cm.

The electrical structure of the shower-cloud is similar to that of the thunder-cloud, but the shower-cloud does not usually have the positive charge in the base; and the vertical extent of the negative charge is substantially smaller. At Kew the negative charge extended from the base at 1·5 km. up to 3 km. for showers, up to 4·5 km. for moderate thunderstorms and up to 7·5 km. for violent thunderstorms, with a maximum of 9·5 km. Schonland and Malan estimated that in South African storms the negative region extended from 3·5 km. (above sea-level) up to levels between 4·5 km. and 10 km. according to the violence of the storm. Radar investigations support these conclusions. They indicate that the vertical columns giving radar echoes are greater (in height) for thunderstorms than for showers, and the echoes are much more intense from thunderstorms. The 'radar cloud' of thunderstorms usually reaches a height at which the temperature is below − 40° C. The 'radar cloud' of showers may reach only to − 10° C. and practically never reaches beyond − 30° C.

The generation of the main charges in the thunder-cloud, and probably also in the shower-cloud, appears to depend on the presence of ice crystals. It may be brought about by impact, as suggested by Simpson, or it may be due to splintering, now known to occur, during the rapid growth of the crystals by accretion. The vertical separation of the charges is due to gravity. Either the negative charge is on ice particles or drops, and the positive charge on ions, or the negative charge is on large ice crystals and the positive charge on small fragments of ice crystals. In both cases the negative charge is carried downwards by gravity and the positive charge left in the upper part of the cloud.

The generation of the pocket of positive charge in the base is probably due to the breaking of large water drops. The charge is practically always found in a region where the temperature is above freezing point. In fact, one of the differences between the showers and thunderstorms investigated at Kew is that the latter have their bases well below the freezing level and therefore at a temperature well above freezing point. Aircraft and radar observations indicate that the necessary accumulation of large drops in the lower part of the cloud is initiated by the strong updraughts which carry a copious supply of water to high levels.

Schonland has suggested an alternative method of generation of this lower positive charge on lines indicated tentatively by Whipple in 1938. If upward-moving positive ions due to point-discharge from the ground attach themselves to water drops in the base of the cloud, their electrical mobility disappears and they become concentrated into a pocket of positive charge in the cloud.

Dr. R. H. Golde dealt with the question of so-called 'lightning nests'—regions with an excessive concentration of lightning discharges. The published evidence for these, he said, does not appear sufficient to satisfy rigorous statistical examination; but it has been suggested that underground watercourses or geological faults or unusual conductivity of the air over a region might produce such 'nests'. Dr. Golde has examined theoretically the possible effects of the ground on concentration of lightning. The height of the advancing tip of a downward-moving leader stroke at which complete breakdown of the remaining air space can be expected to occur in the form of an upward streamer from the ground to this advancing tip is about 15 metres for a stroke of average intensity and 100 metres for a stroke of maximum intensity. Field observations confirm that these theoretical values are of the right order of magnitude. It is therefore only at these comparatively small heights that the point ultimately to be struck is determined. A buried cable or a lightning conductor 10 m. high may attract lightning strokes over distances, increasing with the intensity of the stroke, but less, for the cable, than 100 metres and, for the lightning conductor, than 200 metres. A narrow geological fault or an underground water-course, surrounded by soil of high resistivity, can be expected to be intermediate between these two in its effects on the electrostatic field. They may thus cause narrowly localized 'concentrations' of lightning discharges; but a concentration over larger areas can only be explained by topographical features or by properties of the atmosphere over these areas and not by features below the earth's surface. On the average in England, the estimated number of flashes to a strip 200 m. wide and 1 km. long is less than one in two years; to a circle of 100 m. radius it is less than one in ten years. Dr. Tromp, of Leyden, convinced that lightning flashes do tend to be concentrated in zones of high conductivity gradients at the earth's surface, has suggested a systematic study of the geology and soil conductivity at points struck by lightning over a number of years.

In reply to a query, Dr. Golde said that magnetization of basaltic rocks is caused not infrequently by lightning; and this phenomenon has, in fact, led to the development of magnetic devices for indicating the magnitude of the currents in lightning flashes to earth.

Dr. E. T. Pierce gave a brief account of investigations into the field changes to be expected from negatively charged leaders starting from the base of the thundercloud, advancing with speeds of $10^{7}$–$10^{8}$ cm./sec. and carrying currents of the order of 100 amp. In such leaders are conditions exist, and corona currents develop. He has derived curves for the change of field with time during leader stages, using a formula for the corona current, $I_c = k[\int_0^l x dl]^2$, more general than that of Bruce in that $x$, the general field-strength, is not assumed constant but is a function of $l$, the length of the leader from its origin. The curves derived are in good agreement with those actually recorded at Cambridge. The value of the corona constant $k$ comes out at $10^{-16}$ M.K.S. units, a value consistent with McEachron's observations on the Empire State Building, New York. If the general field, $x$, increases slowly upwards, the leader field-

change approximates to the α-type—leaders of uniform velocity $2 \times 10^7$ cm./sec. As the increase of general field with height becomes more rapid, the leader field-change approaches more closely the β-type—leaders moving during the first part of their track at a much higher velocity, $1{\cdot}5 \times 10^8$ cm./sec.

Mr. J. Durward, deputy director, Meteorological Office, contributed two observations of unusual phenomena. In the summer of 1934 he was motoring along the south bank of Loch Tummel. It began to rain heavily, with slight or moderate thunder and lightning. His son, a boy of twelve, was opening the iron gates, spaced at regular intervals on this road, and found one difficult to open. Mr. Durward, while walking the short distance from the motor-car to the gate to assist his son, saw among the pine trees on his left what looked like a ball of fire about 12 in. in diameter moving towards them. It struck the iron gate-post farthest from the latch. There was no noise, but the boy, who had his hand on the latch, gave a yell; for the next few hours he was unable to lower his arm. The second incident was in the late summer of 1938 *en route* for Iraq in a B.O.A.C. flying-boat. Just after passing the Toulouse gap, in dense nimbostratus cloud at a height of 8,500 ft., what appeared to be a ball of fire entered the rear cabin and burst with a loud explosion. The captain of the aircraft told Mr. Durward about one to two minutes after the explosion that he had had the cockpit window open, for visibility, that the ball of fire entered by the open window, burned off his eyebrows, some of his hair, a hole in his safety belt and dispatch case. From the cockpit the ball passed through the dispatch clerk's 'office' and the forward passenger cabin without harming anybody or anything—only in the rear cabin was there an explosion. About the same time as the aircraft was struck, the hotel at Marseilles, where the passengers were to spend the night, was struck by a 'coup de foudre' and burned out. Mr. J. F. Shipley said that fifty years ago on a hot oppressive afternoon he had seen from the top of an omnibus in the Fulham Road, London, 'ball lightning' apparently about 6 in. in diameter and 15 yds. away, floating in the air. As he watched it, he saw a flash of lightning and the ball disappeared. There was no noise.

These and other observations, notably some of those related by F. Sauter in the *Meteorologische Zeitschrift* of July 1895, by W. J. Humphreys in the *Proceedings of the American Philosophical Society* of 1936, and by W. Brand in "Der Kugelblitz" (reviewed in *Nature*, **113**, 677; 1924) dispose of the contention that ball lightning is not a real physical phenomenon but an optical illusion—an after-effect of the flash of ordinary lightning or St. Elmo's fire. Not only is ball lightning a physical phenomenon, but also there are two distinct kinds—the noiseless and the explosive type.

The most likely source of ball lightning is that originally suggested by Dr. T. E. Allibone and repeated in the discussion, namely, the junction of the tip of the downward moving negatively charged stepped leader with the end of the upward positive streamer from earth. Th. Neugebauer showed that a concentrated ball of negative electrons and positive ions is stable up to high temperatures, the limiting temperature increasing with increasing electron density. The ball could persist for some time owing to the diminished rate of recombination of electrons and ions at high temperatures. If the original electron density and temperature are relatively low, the ball simply decreases in size, at the same time increasing in density and therefore in stability, and finally disappears silently owing to cooling by radiation. If, however, the original electron density and temperature are high, the electron density may diminish rapidly enough for the critical temperature for stability to fall below the actual temperature of the ball, which then explodes. The electron density must be very high, nearly $10^{20}$ electrons per c.c., to ensure stability at the temperatures of a luminous ball. Such densities are possible at the tip of a lightning stroke; but they are beyond the range so far achieved in the laboratory. Even in the lightning stroke, away from the tip, the maximum estimated density is only of the order $10^{15}$–$10^{16}$ per c.c. The comparative rarity of ball lightning is therefore not surprising.

E. Gold

# PROGRESS IN COLOUR TELEVISION

By Dr. R. L. SMITH-ROSE

ALTHOUGH the public television service started in Great Britain before the Second World War, the active development of a scheme for giving almost nation-wide coverage to this service has taken practical shape during the past five years. In the United States, television as a direct practical application of some of the electronic techniques developed during the War years caught the public imagination to such an extent that the television industry there, starting from almost nothing a few years ago, is now claimed to be one of the most widespread and active industries in the country. With its 107 television transmitting stations operating in the United States and more than thirteen million receiving sets each containing a cathode-ray tube for the display of the received picture, it is interesting to recall that the suggestion for using beams of electrons for this purpose was first made by A. A. Campbell Swinton in a letter published in *Nature* in 1908[1]. It was clear even at that date that, for the successful transmission of pictures to a distance, these pictures must be reproduced at least ten times a second, and that the electrical signals carrying the picture information would be subject to variations of about 160,000 times a second.

## Television and Radio Spectrum Band-width

From these elementary considerations have been built up the various television systems in use to-day, which present the pictures at a repetition-rate of 25 a second in Europe, and 30 a second in the United States. The quality of reproduction may be partly specified by the number of lines in which the picture is scanned; and for the four main systems of transmission which have received attention at international conferences in recent years, the numbers of lines used are 405 (Great Britain), 525 (United States), 625 (Netherlands) and 819 (France). The detailed quality of the picture only increases with the number of lines if the frequency channel used for the transmission of the signals is adequate. Thus for the four systems referred to above, the ideal transmission characteristics require bands of width 5, 6, 7 and 14 Mc./s. respectively[2]. When it is realized that the total frequency band used for the television service in

Great Britain at present is 27 Mc./s. (41–68 Mc./s.), it will be evident that in the development of a practical scheme of television some compromise must be made between the quality of picture transmission and the number of separate channels required for various stations. Furthermore, the greater the frequency band required for the vision signals, the greater is the power and cost of the sending station required, and the more elaborate technically and the more expensive are the radio relay stations and the interconnecting cables required for the exchange of programmes between stations within the same or in different countries. It is these considerations, both technical and economic, which resulted in the plan now being developed by the British Broadcasting Corporation for the division of the above frequency band into five channels, and the installation of five high-power transmitting stations, with outputs approaching 50 kW., and of five medium-power stations, probably of 5 kW., operating in the same channels[3]. By a suitable geographical separation between the high- and medium-power co-channel stations, and the use of vertical polarization for the main and horizontal polarization for the subsidiary stations, it is expected that a single-programme television service will be available.

In the United States, a wider frequency band is available and provides twelve channels each of 6 Mc./s. Even so, the development of television broadcasting was so rapid that in the autumn of 1947, when 107 transmitting stations had been licensed, the Federal Communications Commission called a halt on further expansion pending an investigation of the interference which was then being reported between stations operating in the same or adjacent channels. Although several hundred applications for licences for new stations have been made to the Commission in the past few years, this 'freeze', as it is called in the United States, still prevails. Meanwhile, much intensive scientific research and technical development have been devoted to the problems involved in the presentation of pictures in colour, and to the possibilities of using the higher frequencies in the band 490–960 Mc./s. for further television services.

## Basis of Colour Television

Since Newton demonstrated the visible spectrum more than two centuries ago, it has been known that white light could be produced by the addition of a number of primary colours. It was later shown that the eye mechanism is sensitive to three primary colours only; and about one hundred years ago Clerk Maxwell laid the foundations of modern quantitative three-colour theory and colorimetry. The addition of the three primary colours, red, green and blue, in correct proportions is the basis of modern colour television; and while it may not be possible to produce every colour by this means, this is not a serious limitation in television. Setting aside for the moment the problems at the transmitting station, the presentation of a coloured picture before the viewer at the receiving station is that of producing three separate pictures in the primary colours and combining them into a single picture. This can clearly be done either by the production of three coloured lights by means of lamps or fluorescent screens emitting the desired colours, or by means of a screen image radiating energy over most of the visible spectrum, the picture then being viewed through filters producing the appropriate coloured lights. The variation of the signals from the television transmitting station will vary the strength of the coloured lights corresponding to the colours before the camera, and the mixture of these lights will reproduce the appropriate colour sensations to the viewer.

Early experiments were made in Great Britain on both systems. At the British Association meeting in 1928, J. L. Baird gave a demonstration of three-colour television using a mechanical scanning arrangement[4]. Eleven years later, in 1939, Baird also gave a demonstration of two-colour television using a cathode-ray tube with a white screen viewed through a rotating filter disk[5]. The first demonstration in the United States was given in 1929 by staff of the Bell Telephone Laboratories using separate lamps for the three primary colours[6]. In 1944, Baird also demonstrated the use of a screen coated with materials giving different fluorescent colours for the direct viewing of a colour picture in a single cathode-ray tube[7].

From these early experiments, the most spectacular developments have taken place in the United States since the end of the War, and particularly in the past few years during which the expansion of black-and-white television broadcasting has been frozen. A most interesting and informative account of these developments was given last October in a special "Color-Television Issue" of the *Proceedings of the Institute of Radio Engineers*[8]. This issue contains twenty papers describing the results of much recent scientific research in this subject, and the detailed development of the two main systems which have been evolved and which are now competing for the right to be established as the standard colour-television service for the United States. Among these papers, special attention may be directed to an excellent survey entitled "Alternative Approaches to Color Television" by D. G. Fink, to a review paper on "Color Television and Colorimetry" by W. T. Wintringham, and to the one by P. C. Goldmark, J. W. Christensen and J. J. Reeves entitled "Color Television—U.S.A. Standard", which describes the standards established by the Federal Communications Commission for the colour system which was in use in the United States for a few months during 1951. Eleven of the papers in the above *Proceedings* are by members of the staff of Radio Corporation of America, and these were also published last September in a special issue of the *RCA Review*[9].

That interest in this subject is not confined to the United States is demonstrated by the fact that the September 1951 issue of the *A.W.A. Technical Review*, published in Sydney by Amalgamated Wireless (Australasia), Ltd., contains a long article entitled "A Survey of the Methods and Colorimetric Principles of Colour Television", by J. E. Benson. This paper deals very fully, in a form useful to television engineers, with the basic principles of colour specification, measurement and calculation. It is noteworthy for a number of illustrations in full colour, describing the spectrum, the colour triangle and the additive and subtractive results of colour mixture.

## Colour Television and Band-width

At first it was thought that the reproduction of television pictures in natural colour involved the transmission of a similar amount of information in each of the three primary colours. If this were so,

each picture on the basis already explained would have to be scanned and built up in one-third of the time necessary for black-and-white transmission, so that the band-widths required for accurate reproduction would be three times as great. Thus, for the current British and American systems, these band-widths would be 15 and 18 Mc./s. respectively, which would prove an alarming prospect to those responsible for allotting frequency channels in the quite narrow portions of the radio spectrum available for television.

Under the auspices of the Columbia Broadcasting System, early experiments were conducted by Dr. Goldmark and his associates in development of the rotating-disk technique used by Baird. These led to the proposal and demonstration in 1946 of colour television in a 12-Mc./s. band, using the United States standards of 525 lines a picture and 24 complete pictures a second. Following the halt in the expansion of television broadcasting, however, the Federal Communications Commission decided that any proposals for a colour television service must assume that the channel available is the same as for black-and-white, that is, 6 Mc./s. This decision proved a challenge which has been taken up by scientific workers and engineers in many parts of the United States, and has provided the incentive for widespread research and developments, the full results of which have yet to be seen and may have far-reaching consequences in many fields associated with reproduction in colour. Physicists have made a renewed investigation into the sensations of colour from both the physical and physiological points of view; and the radio and electronic engineers have been ascertaining what is the essential minimum amount of information that has to be transmitted (and thus the smallest band-width necessary) to permit the apparently complete reproduction of a moving picture in colour. While it is much too early to state which of the several possible schemes now being developed will ultimately achieve the status of a public broadcasting service, there have emerged up to the present two distinct systems each of which is based on the principles demonstrated by Baird many years ago. In the one system, the pictures are first presented in sequence on a black-and-white screen which is then viewed through a rotating colour disk. The other system uses for reception a cathode-ray tube with three sets of phosphorescent materials each fluorescing in one of the three primary colours, so that the picture is built up directly in colour on the screen of the tube.

## The Field-sequential System

In 1949 the Columbia Broadcasting System proposed a modified scheme to meet the requirements of the Federal Communications Commission. This involved scanning the pictures or scene to be transmitted in each of the three colours in sequence, both lines and the colours being interlaced, and resulting in a 405-line picture reproduced completely twenty-four times a second (144 fields a second). Hence both line- and field-scanning rates differ from the American black-and-white standard of 525 lines and 30 pictures a second; and the conversion of existing receivers involves the alteration of two scanning oscillators and the provision of the rotating colour-filter disk. Apart from this, however, the main advantage of the system appears to be the comparative simplicity of the terminal apparatus and the excellent performance in tonal gradation and colour range. The high field-scanning rate is necessary to reduce the flicker which would be noticeable at lower values.

It should be noted that after extensive hearings and demonstrations the Federal Communications Commission at first decided in favour of this system for commercial development, and the first public colour-television broadcasts were inaugurated by the Columbia Broadcasting System in New York in June 1951. This service was stopped, however, a few months later in order to ensure that the production of electronic equipment for defence measures was not hampered by the consequences of large-scale development of television receivers.

## The Dot-sequential System

The alternative system of presenting the pictures in colour has been developed principally by the engineers and scientific workers of the Radio Corporation of America. As first demonstrated to the Federal Communications Commission in 1946, three picture-tubes were used, with screens giving the primary colours, and operating simultaneously on the black-and-white standards. The three coloured images were superimposed by an optical system to give a single picture in colour. It was later recognized, first that the resolution required in the three primary images was not the same, the highest required being in the green, with less in the red and much less in the blue; secondly, that the colour signals could be transmitted in sequence by a high-speed electronic sampling technique; and thirdly, that information on the brightness of the picture could be transmitted in the form of a 'grey' (black-and-white) signal superimposed on the colour signals.

The appreciation and application of these principles was crowned by the successful development of a tri-colour cathode-ray tube, which incorporates three electron-gun systems, one for each colour, and a fluorescent screen made up of a mosaic pattern of 600,000 separate phosphor dots, arranged in sets of three and fluorescing in each of the three primary colours. Thus was demonstrated to the Federal Communications Commission during 1949–50 the dot-sequential colour-television system. At the camera end, the three picture tubes are sampled in sequence at a sub-carrier frequency of $3 \times 3{\cdot}58 = 10{\cdot}74$ Mc./s., and the resulting colour signal pulses are transmitted in a band-width of 2 Mc./s. This signal provides essentially no brightness contrast; but this quality is obtained separately by a combined signal derived from all three camera tubes and transmitted in a separate band of the same width. At the receiving end, the combined result of these signals closely approaches that produced by a simultaneous transmission system using a separate 4-Mc./s. band for each primary colour, or 12 Mc./s. in all. The success achieved in the practical demonstration of this system is considered to be one of the most striking accomplishments of compression of information and spectrum economy in the history of telecommunications.

Many demonstrations of this system of colour television evolved by the Radio Corporation of America have been given in the United States during the past two years, including recently one in which the picture was projected on to a cinema screen of size 12 ft. × 9 ft. Among the advantages claimed for the system is that of full compatibility with the black-and-white technique; by this is meant that

the colour transmissions can be received (in black-and-white) on the very large number of television receivers in current use. Apart from this, the system gives on the tri-colour tube a colour picture of high quality and good resolution with freedom from flicker; and there is no doubt that, if the economics of the more complex receiving circuits and cathode-ray tube can be made satisfactory, this dot-sequential system is a serious rival to the field-sequential system already described.

### Other Advances

This rapid and widespread development of television and the obvious advantages of transmission in colour have attracted a number of other workers and organizations who are making substantial contributions to the technique of the subject. A 'line-sequential' system has been developed, for example, in which the picture is scanned and reproduced in successive lines in the three primary colours. In addition, the General Electric Co. in the United States has announced a new system in which bandwidth is economized by a process of frequency interlacing of the signals which simultaneously carry the colour information[10]. Other research is providing a better understanding of the subject of colorimetry, including especially its physiological aspects, and the advantages and limitations of the sampling process of transmitting and building up a colour picture. All these developments will be watched with great interest, as will also the present deliberations of the United States National Television System Committee, the conclusions of which should materially assist the Federal Communications Commission in making future decisions on the public television-broadcasting service to be developed in the United States.


[1] Swinton, A. A. Campbell, *Nature*, **78**, 151 (1908).
[2] C.C.I.R. Documents of the Sixth Plenary Assembly, Geneva, 1, 209 (1951).
[3] Report of the Broadcasting Committee, 1949, *Nature*, **167**, 617 (1951).
[4] *Nature*, **122**, 233 (1928).
[5] *Wireless World*, **45**, 145 (1939) and **48**, 31 (1942).
[6] Ives, H. E., *Bell. Lab. Record*, **7**, 439 (1929). Ives, H. E., and Johnsrud, A. L., *J. Opt. Soc. Amer.*, **20**, 11 (1930).
[7] *Wireless World*, **50**, 316 (1944).
[8] *Proc. Inst. Radio Eng.*, **39**, No. 10 (1951).
[9] *R.C.A. Review*, **12**, No. 3, Part 2 (1951).
[10] *Wireless World*, **56**, 443 (1950).


# NEWS and VIEWS

## Fifty Years of Service to Microscopy, 1901-51

The firm of Flatters and Garnett, Ltd., has issued, under the title of "50 Years' Service to Microscopy, 1901 to 1951" (pp. 24+12 plates; 1952), a brief account of its history with justifiable pride of achievement. From very small beginnings its contacts now extend into the five continents, and its name has become a household word in biology. The firm was started by Abraham Flatters, who as an unskilled labourer attended lectures for working men by Prof. Milnes Marshall, a teacher of zoology of rare gift for creating enthusiasm and interest in his subject. Flatters' interest in microscopy was so stimulated that, not being able to spare money for purchases, he used the broken glass of railway carriage windows to make his slides, and, borrowing Asa Gray's "Botany" from the library, he made a complete copy of it, including the illustrations. Marshall, recognizing Flatters' keenness, obtained for him a post with Sinel and Hornell, of Jersey; with this experience, Flatters returned to Manchester and set up in business, making microscopical preparations and lantern slides. He was appointed a lecturer in microscopical technique in the Manchester College of Technology and published several small papers dealing with aspects of microscopical work. Mr. Charles Garnett, also after an interesting career, joined Flatters in 1901; but later the latter withdrew and the present firm includes Flatters only as a name. Manchester saw the birth and development of the firm, and Manchester institutions, notably the University and Microscopical Society, have been closely correlated with its growth. A very friendly atmosphere has always existed, and still does exist, between the biology departments of the University and the firm. Mr. John B. Garnett, who is the head of the firm, and his son, Mr. Wilfred J. Garnett, himself a graduate of the University, are always ready to discuss optical problems and offer friendly and helpful advice. After fifty years, in spite of serious setbacks such as two World Wars and a destructive fire, Flatters and Garnett, Ltd., is still extending its sphere of usefulness by keeping its finger on the pulse of biological teaching and research.

## Medical and Human Problems in the Coal Industry

The National Coal Board has set up four panels as follows to advise on research into medical and human problems in the coal industry. *Epidemiology Panel:* Dr. D. D. Reid (*chairman*), reader in epidemiology, University of London; G. Bridgemore Brown, assistant secretary (safety), Production Department, National Coal Board; R. F. George, chief statistician, National Coal Board; J. C. Hobbs, Ministry of National Insurance; J. F. Houldsworth, Central Research Establishment of the National Coal Board, Stoke Orchard; Dr. W. P. D. Logan, chief medical statistician, Registrar General's Office; Dr. J. Rogan, chief medical officer, National Coal Board; and Dr. T. D. Spencer, divisional medical officer, North Western Division, National Coal Board. *Psychology Panel:* Prof. G. C. Drew (*chairman*), Department of Psychology, University of Bristol; Dr. C. B. Frisby, director, National Institute of Industrial Psychology; Dr. C. G. Gooding, divisional medical officer, Scottish Division, National Coal Board; Dr. N. H. Mackworth, assistant director, Applied Psychology Research Unit, University of Cambridge; Dr. J. Rogan; J. W. Whitfield, lecturer in psychology, University of London; and Dr. T. Macbeth Wilson, director, Tavistock Institute of Human Relations. *Physiology Panel:* Prof. E. Killick (*chairman*), Department of Physiology, Royal Free Hospital School of Medicine; Dr. K. W. Donald, reader, Medical Professorial Unit, Queen Elizabeth Hospital, Birmingham; Dr. T. K. Elliott, divisional medical officer, West Midlands Division, National Coal Board; Dr. H. R. Noltie, lecturer in physiology, School of Medicine, Leeds; Dr. R. Passmore, lecturer in industrial physiology, University of Edinburgh; Dr. J. Rogan; and Dr. A. G. M. Weddell and Dr. J. S. Weiner, readers, Department of Human Anatomy, University of Oxford. *Industrial Medicine Panel:* Dr. J. G. Scadding (*chairman*),

dean of the Institute of Diseases of the Chest, Brompton Hospital; Dr. A. J. Amer, chief medical officer, Imperial Chemical Industries, Ltd.; Prof. R. C. Browne, Department of Industrial Health, University of Durham; Dr. J. C. Gilson, deputy director, Pneumoconiosis Research Unit, Medical Research Council; Dr. T. E. Howell, chief medical inspector, Ministry of Fuel and Power; Dr. T. H. Jenkins, divisional medical officer, South Western Division, National Coal Board; Dr. J. Rogan; Dr. J. Trefor Watkins, divisional medical officer, East Midlands Division, National Coal Board. Dr. J. S. McLintock, assistant to the chief medical officer of the National Coal Board, is the secretary of the Panels.

## Biochemistry and Virus Laboratory of the University of California, Berkeley

THE opening of the new Biochemistry and Virus Laboratory of the University of California, Berkeley, which has been under construction since October 1950, has been arranged for October 10, and as part of the ceremony a symposium will be held in which four addresses on biochemistry and four on viruses will be given by distinguished men of science. The symposium, as well as conducted tours through the Laboratory, will be open to the public. The opening of the Emil Fischer Library of the Laboratory will be accompanied by a special observance of the centenary of the birth of Emil Fischer on October 9, 1852. The Laboratory building is being constructed with funds provided by the State of California, although special equipment costing more than 250,000 dollars has been provided by funds made available by Lederle Laboratories, the National Foundation for Infantile Paralysis, Inc., the Rockefeller Foundation and the University of California; the total cost is two million dollars. The building has five floors and a roof penthouse and glasshouse, and is 200 by 60 ft. in size. It stands just inside the east entrance to the Berkeley campus. Facilities for teaching are divided into two parts, 240 elementary students being accommodated on the ground floor and 80 advanced students on the second floor. Research facilities for approximately a hundred graduate students and about thirty senior staff members are provided on the upper floors of the building. The Emil Fischer Library, a machine shop, and special facilities for electron microscopy, ultracentrifugation, electrophoresis, X-ray analysis, analysis of stable and radioactive isotopes, microbiological assays, etc., are on the fourth floor. Special facilities for the investigation of dangerous viruses requiring complete isolation are provided on the fifth floor. Altogether, many new and unusual features are incorporated in the building. Research activities of the staff cover many aspects of the biochemistry of animals, plants and micro-organisms basic to an understanding of the functioning of living organisms in health and in disease. Members of the staff of the Virus Laboratory, under the direction of Dr. W. M. Stanley, are giving special attention to studies of the modes of reproduction and mutation of viruses.

## Michaelsen Institute of the University of Copenhagen

A NEW Institute of the University of Copenhagen, to be known as the Michaelsen Institute, will be opened on April 16. At the ceremony, Prof. E. D. Adrian, president of the Royal Society of London, will speak on "Sensory Discrimination". The new Institute has been sponsored jointly by the Michaelsen Foundation, the Carlsberg Foundation, the Rockefeller Foundation and the Danish State. On three of the floors, it houses the Institute of Neurophysiology (director, Prof. Fritz Buchthal), and on a fourth the Isotope Section of the Zoophysiological Laboratory (director, Prof. H. H. Ussing). The occasion will mark the opening of the first scientific institute to be finished in Denmark since the Second World War.

## Indonesian Journal for Natural Science

THE first issue of a new monthly journal, the *Indonesian Journal for Natural Science* (*Madjalah Ilmu Alam. Untuk Indonesia*) (R. 12 a year or R. 2 a number), marks the move of the Royal Physical Society in Indonesia (Perhimpunan Ilmu Alam Indonesia—Koninklijke Natuurkundige Vereniging in Indonesie) from Djakarta to Bandung. This Society has a long history, for it was founded in 1850 and, since that date, has issued a journal under various names but always with a continuous sequence of volume numbers. Thus the first issue of the new *Journal* is Volume 107 (Nos. 1, 2 and 3; 1951), for it succeeds the old *Chronica Naturæ*, the last volume of which was numbered 106. Bandung is the seat of two Faculties of the University of Indonesia, those of Mathematics and Natural Science and of Technical Science, and hence the Society has moved to a scientific atmosphere which should be favourable to its growth. The Society covers a wider field than the modern meaning attached to its name, for the *Journal* covers all aspects of science, and the first issue has as much space devoted to biological topics as to physics and chemistry. The contents of this issue include review articles on special topics; scientific notes; communications and announcements; book reviews; new publications; and personalia. Although it is intended to publish as much as possible in English, quite a large proportion of the articles are in Dutch. The address of the *Journal* is Djalan Ganeça 10, Bandung, Batavia, and contributions should be sent to the editor, Prof. Th. H. F. Klompé. The commercial representative in the Netherlands is J. B. Reelick, Keizersgracht 790, Postbox 863, Amsterdam.

## Government Loans for Fuel-Saving Equipment

SPEAKING in the adjournment debate in the House of Commons on March 7 on Mr. M. Philips Price's motion on the need for comprehensive measures for the more efficient utilization of coal, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, referred to the growing awareness of industry that insulation and the installation of fuel-saving equipment usually offer a quick return in terms of fuel saved. He said that the Government is doing what it can to ensure that the supply of fuel-saving equipment and insulating materials is adequate, and made the important announcement that the Government is prepared to make arrangements whereby experimentally, for one year, a sum of £1 million would be available at full commercial rates for loans to firms who wish to insulate their factories and install fuel-saving equipment. This sum would cover both the structural insulation of factories built before a date to be prescribed, and the installation, by a prescribed date, of approved fuel-saving equipment. The motion, with the idea of which though not the exact form the Minister agreed, was carried, and it was indicated in the debate that it also has the support of the Parliamentary and Scientific Committee.

## University of New Zealand : Vice-Chancellorship

Dr. G. A. Currie has been appointed vice-chancellor of the University of New Zealand in succession to Dr. Ian A. Gordon. Dr. Currie, a native of Banffshire and a graduate of the University of Aberdeen, has been vice-chancellor of the University of Western Australia since 1940, and previously held the positions of professor of agriculture in that University and of senior research officer in the Council of Scientific and Industrial Research at Canberra. He will take up duty at Wellington in May.

Dr. Ian A. Gordon, who has been vice-chancellor of the University of New Zealand since 1947, has resumed the duties of the chair of English language and literature at Victoria University College, Wellington. He is a graduate in classics and English of the University of Edinburgh, where he held the Dickson Travelling Scholarship and was Elliot prizeman. He lectured in English at the University of Edinburgh and at Heriot Watt College before his appointment to Victoria University College in 1937. He was chairman of the Executive Council of the Association of Universities of the British Commonwealth in 1949.

## Animal Breeding Research Organization

The Agricultural Research Council announces that, following the retirement of Prof. R. G. White, changes have been made in the administration of the Animal Breeding and Genetics Research Organization. The staff of the former Genetics Laboratory of the Organization continues under the direction of Prof. C. H. Waddington, attached to the Genetics Department of the University of Edinburgh, and their work will be financed by the Council by means of a block grant. The Organization, with the altered title of Animal Breeding Research Organization, will be under the direction of Dr. H. P. Donald. It now comprises a headquarters with laboratories in South Oswald Road, Edinburgh, and breeding research farms in various parts of Great Britain. It will continue to be directly financed and controlled by the Agricultural Research Council.

## South-Eastern Union of Scientific Societies : Annual Congress

The South-Eastern Union of Scientific Societies will hold its fifty-seventh annual congress at the Devonshire Park Pavilion, Eastbourne, during April 24–27. The president-elect is Mr. James Fisher, who will give an address on "Bird Numbers". The presidents of the four Sections of the Union and the titles of their addresses are as follows : *Archæology*, Mr. A. Cecil Piper, on "The History of a Downland Village—Alfriston" ; *Botany*, Dr. J. Heslop-Harrison, on "Recent Researches on the British Marsh and Spotted Orchids" ; *Geology*, Prof. P. Allen, on "Our Chalky Heritage" ; *Zoology*, Dr. W. S. Bristowe, on "The Spiders of Islands". Further details of the meeting can be obtained from the secretary of the Union, Mr. Francis Rose, The Forge House, East Malling, Kent, or the honorary local secretary, Miss M. A. Ash, 24 Mayfield Place, Eastbourne, Sussex.

## Announcements

We regret to announce the death, which occurred on March 30, of Sir Leonard Hill, F.R.S., formerly director of the Department of Applied Physiology, National Institute for Medical Research, at the age of eighty-five.

W. D. M. Paton has been appointed to a University readership in pharmacology and therapeutics, tenable at University College and University College Hospital Medical School, London.

The degree of D.Sc. in the University of London has been conferred on the following : Harry Wilman (Imperial College of Science and Technology) ; R. K. Eisenschitz (appointed teacher at Queen Mary College) ; H. H. Hopkins (external).

The Paint Research Station, Waldegrave Road, Teddington, Middlesex, which is the registered office and laboratories of the Research Association of British Paint, Colour and Varnish Manufacturers, is holding an 'open week' during April 21–25, when the laboratories will be open for inspection by members of the Association and others interested in the work.

A David Anderson-Berry Silver-gilt Medal, together with a sum of money amounting to about £100, will be awarded in 1953 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the therapeutical effect of X-rays on human diseases. Both published and unpublished work will be considered. Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, by March 31, 1953.

The Association of Agriculture, the Institute of Rural Life at Home and Overseas, and Shuttleworth College are arranging jointly a course on "Lessons from the Land", to be held at Shuttleworth College, Old Warden Park, Biggleswade, Beds, during April 15–18. The course will consist of a number of lectures, with films and visits to farms, in which rural life will be discussed by reference to relevant topics in geography, biology, social studies, etc. The fee for the course is £3. Further details can be obtained from the General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1.

The German Geophysical Society and the Meteorological Society in Hamburg will be holding a joint conference in Hamburg during August 24–30. Meteorological topics pertaining to the sea will be discussed during August 24–26, and geophysics during August 28–30. On the morning of August 27 a session on "Geophysical Science in the Service of Navigation" will be held, with Prof. A. Defant in the chair. Those intending to read papers should send in notification by July 1 to the appropriate organization—Deutsche Geophysikalische Gesellschaft, Stuttgart-O, Richard Wagner Strasse 15, or Meteorologische Gesellschaft in Hamburg, Hamburg 4, Bernhard Nocht Strasse 76.

The Eleventh International Congress of Philosophy will be held in Brussels during August 20–26, 1953. During the mornings the plenary sessions will take place, and in the afternoons the sectional sessions. For plenary sessions those reading papers will be allowed twenty minutes for each paper with fifty minutes of discussion, and for the sectional sessions the periods allowed will be ten and forty-five minutes respectively. Members of the Congress are restricted to reading one paper only ; such communications may be submitted in French, English, German, Italian or Spanish and must be sent to the secretariat not later than December 15. Further details can be obtained from the secretariat, Ch. Perelman, 32 rue de la Pêcherie, Uccle-Bruxelles.

# LIPID METABOLISM

## BIOCHEMICAL SOCIETY SYMPOSIUM

A SYMPOSIUM on lipid metabolism arranged by the Biochemical Society was held on February 16 in the London School of Hygiene and Tropical Medicine. A large audience of members and visitors at both the morning and the afternoon sessions showed great interest in the subjects discussed; these were concerned largely with the absorption of dietary fat by animals and the synthesis of fat in the glands of lactating animals.

It had originally been intended that the late Prof. H. S. Raper should preside at the morning session. In consequence of his death last December, Dr. H. J. Channon took the chair; he opened his remarks with a personal tribute to Prof. Raper's worth as a friend and as a biochemist. Prof. Raper had prepared, before his death, an introduction to the symposium which was given to the meeting by Dr. Channon, and which took the form of a historical survey of fat metabolism, absorption and oxidative breakdown. Prof. Raper had expressed a marked preference for the term 'fat' instead of 'lipid', a point which seems appropriate when the metabolism of the long-chain compounds present in glycerides, phosphatides or cerebrosides is under discussion: the term 'lipid' as currently employed covers other materials (sterols, carotenoids, vitamins) which are soluble in fats or in fat-solvents, but which have no chemical relationship to the long-chain compounds which are the basis of true fats. After remarking that usually the living cell does not employ the synthetical methods of the organic chemist, Prof. Raper had commented on the renewed and accelerated interest of the past few years in the synthesis and metabolism of fats in living organisms. The ideas of fifty years ago of formation of fat from carbohydrate through an intermediate $C_2$ unit had received confirmation and clarification from the studies of Folley, Popják and others. The older view that fat absorption proceeded by hydrolysis and resynthesis of glycerides in the intestinal mucosa had been modified since about 1939 in the light of the work of Frazer and his school. Since Knoop, followed by Dakin, had established in the early years of the century the occurrence of β-oxidation in the oxidative breakdown of fats *in vivo*, much work had revealed the complexities of the action: difficulty in tracing all the intermediate stages seemed to be due to inability to isolate the different enzymes specifically concerned. Prof. Raper had said he would have welcomed discussion of at least two topics not mentioned in the agenda, namely, the formation, location and function of adipose tissues in animals, and the fat metabolism of germinating seeds, of which little is known and a great deal awaits more complete explanation.

In the first communication to the symposium, Prof. A. C. Frazer gave a general review of his studies and conclusions on the particulate nature of fat absorption via the chyle and lymphatic system. In contrast to the older hypotheses of Pflüger and Verzär, which postulated complete hydrolysis and resynthesis of ingested glycerides in the small intestine, Frazer considers that three stages are involved in fat absorption: a partial hydrolysis of fat (some of which proceeds to fatty acids and glycerol, although this process is stepwise through the stages of di- and mono-glycerides, some of which remain present as such), emulsification of unhydrolysed fat (promoted not only by bile acids or fatty acid soaps but also largely by the partly hydrolysed monoglycerides), and absorption of the emulsion of dispersed glyceride particles through the intestinal wall into the lymphatic system. The free fatty acids or their soaps, on the other hand, pass by the portal route. Ease of complete fat hydrolysis depends on the nature of the fatty acids present—glycerides of short-chain acids (tributyrin) are more rapidly and more completely hydrolysed than those of long-chain acids (triolein). In discussion with Dr. G. D. Popják, Prof. Frazer stated that short-chain acids (for example, butyric) are largely destroyed by oxidation for energy purposes, whereas free long-chain acids (for example, oleic) tend to accumulate in the liver. Prof. S. Bergström referred to his own work and that of others which has shown that 'labelled' fatty acids fed by stomach tube to rats appear in their depot fats as glycerides, and Prof. Frazer stressed the very great metabolic activity of the gut, for example, in ester-synthesis as well as hydrolysis, so that the experimental acids may well have been esterified to glycerides before passage through the chyle and eventually into the fat depots.

Dr. J. M. French, a colleague of Prof. Frazer, described work on conditions associated with defective fat absorption in human subjects, such as deficiency in pancreatic enzyme (which appears to inhibit the partial hydrolysis of fat necessary and antecedent to emulsification of neutral fat) or the disease termed sprue in which glyceride absorption is delayed, fatty acid production is abnormally large and leads to increased mucus secretion, and abnormally large proportions of fat are excreted. He directed attention to the difficulties of determining whether fæcal fat is derived from dietary fat, fat normally synthesized by the animal, or fat synthesized in the gut by intestinal microflora.

Dr. R. P. Cook had meanwhile given a general account of the lipid components of fæces, in comparison with the level of absorption of ingested fats of different kinds by various animal species. He suggested that one of the functions of the lipids in the intestine, as well as the skin, is to act as a conditioning agent. Attention was directed to the excretion of lower fatty acids (acetic to hexoic, largely butyric), which is marked in the dog but less so in rats or human subjects. An interesting feature of Dr. Cook's observations related to the fate of cholesterol and other steroids in animals, an issue which was commented upon in discussion by Prof. R. A. Morton, who inquired to what extent particulate absorption of carotenoids or sterols present in solution in glyceride fat goes on, a matter of some importance in connexion with suggested relations of cholesterol to arteriosclerosis and of stigmasterol as an anti-syphilitic factor. The chairman (Dr. Channon) suggested that, since the absorption of dietary glycerides had been the subject of study for many years prior to the progress latterly associated with Prof. Frazer's name, it might require some considerable further time before the even more difficult picture of sterol absorption became clarified.

In the afternoon session (with Prof. T. P. Hilditch in the chair) Dr. Popják summed up his recent work

on the synthesis of lipids from acetate and from glucose containing radioactive carbon. From acetate in which the carboxyl carbon was the isotopic carbon-14, the lactating mammary gland builds up saturated fatty acids in which alternate carbon atoms are radioactive, showing that the saturated acid chains are formed by stepwise lengthening from a shorter acid at the carboxyl end by addition of an acetate group. Glucose had been shown to be as good a source as acetate for the production of both fatty acids and cholesterol, and to be readily broken down (in experiments on rabbits) to acetate. Probably the conversion of glucose to fat involves breakdown of the former to pyruvate, which is decarboxylated to acetate (acetaldehyde). In reply to a question, Dr. Popják afterwards added that the experiments showed that 30–70 per cent of the lower acids in milk fats were synthesized from acetate (or from glucose via acetate) in the mammary gland; in an experiment with lactating rabbits, 30–40 per cent of the short-chain acids in the milk fat were derived from carbon-14 glucose which had been administered.

Dr. S. J. Folley discussed the synthesis of milk fats by ruminants, in the blood of which significant amounts of acetic acid are present. Experiments with isotopic acetic acid ($CH_3.^{14}COOH$) have shown conclusively that acetate is a major source of carbon for fatty-acid formation in the udder, and that the milk short-chain acids arise not by degradation of oleoglycerides (as postulated by Hilditch) but are intermediates in the formation of long-chain acids by stepwise chain elongation. Dr. Folley summarized in equal degree the evidence based on the pattern of glyceride structure in milk fats (which strongly suggests close relationship between these, other body fats and blood glycerides) and concluded with the suggestion that milk fat may have a dual origin—part synthesized in the udder from small molecules, part entering the gland from the blood (and perhaps there undergoing partial chain-shortening). This contribution provoked a vigorous discussion. Prof. Hilditch pointed to a possible reconciliation of the apparently divergent views as to ruminant milk fat formation. From the glyceride structure angle it seems to follow that preformed oleo-glycerides are transformed into short-chain glycerides. This, however, does not necessarily involve chemical degradation of the oleo-group; the same glyceride pattern would result if oleo-groups were *replaced* by butyro-, etc., groups by the process of acyl interchange. The latter process is well known to take place readily *in vitro* and may well proceed in the living tissue—indeed, the selective character of mixed glyceride configuration in plants and animals strongly suggests its operation. Dr. Folley welcomed the suggestion, since it appeared to be in harmony with both sides of the experimental facts which had to be taken into account in a satisfactory explanation. The specific presence in ruminant and some other milk fats of traces of 9-decenoic and 9-dodecenoic acid (apparently derived from oleo-glycerides by degradation) is nevertheless not explained by the acyl interchange hypothesis.

Some discussion also took place as to whether evidence based on ruminant fats is necessarily applicable to all animal fats. While Dr. Popják inclined to the view that the mechanism of milk-fat synthesis is probably basically similar to that of all other fats in the animal, Prof. H. D. Kay remarked upon the essential differences in the blood of ruminants and of other animals: that of the latter contains very little acetic acid, whereas ruminant blood contains as much as 12 mgm. per cent of acetic acid but is lower in glucose content. The conditions of blood supply are therefore quite different. Prof. Hilditch felt that, in view of the many animal species whose milk fats are almost identical with their body fats, ruminants should still be considered a special case, probably differing from the majority of species.

Time had become very short for the reception of the final two communications, which were of the same high order of interest as those in the preceding part of the symposium. Dr. A. L. Lehninger (University of Chicago) gave a most valuable summary of recent work on the enzymatic oxidation of *n*-octanoic acid. The isotope experiments of Weinhouse and his associates indicated that acetoacetate is produced in the oxidation by an essentially random condensation of acetyl residues. Recent refinements of the procedure suggest that more than one molecular species of active acetyl may be formed by β-oxidation of the original acid chain, and that these may differ in ability to serve as precursors of the 'head' and 'tail' of the acetoacetate molecule. Isolated rat liver mitochondria (the only active constituent of rat liver), when used as the oxidase system for saturated fatty acids, require for activity magnesium ions, orthophosphate, adenosine triphosphate, an optimum concentration of electrolytes or of certain non-electrolytes such as sucrose, and an oxidizable 'priming' metabolite, which may be a Krebs citric acid cycle intermediate. The presence of the latter is, however, not essential, for reduced cozymase activates the oxidation equally well. The fatty-acid oxidase system attacks oleic and other natural unsaturated acids and also their *trans*-(elaidic) forms, but requires the presence of a free carboxyl group—long-chain alcohols, aldehydes, amides, etc., are not oxidized. The recent work of Barker and his colleagues on fatty acid synthesis and oxidation in cell-free extracts of *Clostridium kluyveri* indicates the utility of this organism for oxidative studies; a detailed mechanism which accounts for all the recent findings in connexion with conversion of butyric acid to acetoacetate by this oxidase system, and involving the presumption of an intermediate complex of coenzyme-*A* with butyric acid, has been worked out recently by Kennedy and Barker.

Dr. H. M. Sinclair made some important additions to knowledge of the 'essential' fatty acids (linoleic, etc.) especially in regard to their relation with pyridoxine. He showed that the pathological condition in the skin of rats associated with deficiency of linoleic or other essential fatty acid is almost identical with that found in deficiency of pyridoxine; deficiency of either nutrient produces the effect in young rats, but more apparently if both nutrients are deficient. He suggested, as a working hypothesis, that there is failure of growth in fatty-acid deficiency because phosphatides and therefore cell membranes cannot be formed, whereas in pyridoxine deficiency the cause is interference with protein metabolism. Further, in fatty-acid deficiency histamine is liberated from cells more readily than normally, whereas in pyridoxine deficiency there is deficiency of histaminase and therefore inadequate destruction of histamine. He made the further observation that deficiency of essential fatty acids is not fatal to adult rats, although their growth ceases after a certain point, and that the water retention of the tissues may be controlled to a large extent by the presence of these highly unsaturated acids.

In summing-up the proceedings, Prof. Hilditch directed attention to the degree to which, during the day, attention had been focused on the metabolism of *saturated* acids, especially perhaps butyric, and emphasized that the probably different metabolism of *unsaturated* acids (mainly oleic and linoleic), which are by far the most abundant in Nature, merits much more specific attention than it has yet received from biochemists and physiologists.

It will be seen that the symposium covered a wide field. It was one of the most interesting yet held by the Biochemical Society, as may be gathered from the fact that, although it lasted an hour beyond its scheduled time, almost all the large audience remained until it terminated.

## OVERALL DENTAL DIMENSIONS OF HOMINOIDS

By E. H. ASHTON and Prof. S. ZUCKERMAN, C.B., F.R.S.

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OUR attention has recently been directed to the fact that there was a systematic error in the estimates we have provided of the standard deviations of the distribution of individual dimensions of the teeth of apes[1], all our figures being approximately $\sqrt{2}$ times the actual values[2]. The standard errors of the means are correct as published. In the interval since the publication of these earlier observations, we have considerably extended our basic data; but it is nevertheless desirable that we amend certain comparisons[3] between the overall dental dimensions of various fossil hominoids and those of existing apes and men that were based on our incorrect estimates.

The error in these estimates is $\sqrt{2}$ only when the two members of every pair of teeth measured were present in the same skull. It is smaller when some skulls contained only one of each pair of teeth measured. In order to reduce the additional computation involved, and because we shall later be publishing new comparisons based on our larger series of observations and a wider range of statistical techniques, we have employed the factor $\sqrt{2}$ to correct all our previous estimates of the standard deviation of the dimensions of the ape teeth. In the case of the human material, a much larger percentage of skulls contributed only one member of certain pairs of teeth, and the precise correction factors were therefore used. We have in consequence slightly biased our revised comparisons with the ape teeth, in so far as we may now be indicating a few more significant differences between the fossil teeth and those of living apes than actually exist. A random check, using precise correction factors throughout, indicates that the new figures given in the accompanying table are an adequate summary of the results to which comparisons based on our previously published measurements should have led. The figures shown in brackets are the incorrect figures given in our earlier paper[3]. Apart from comparisons with the fossil hominid *Pithecanthropus* (= *Sinanthropus pekinensis*), no new data have been brought into the revised comparisons. The table shows the number of fossil teeth which differ in one or more (overall) dimensions or indices from both the male

Overall Dimensional Correspondences between Hominoid Teeth

"M.D." refers to deciduous teeth; otherwise the permanent dentition is implied

| Fossil species | No. of teeth compared | No. of teeth which differ in one or more dimensions from the: Chimpanzee | Gorilla | Orang-utan | Ancient Egyptian | Australian | *Pithecanthropus* | No. of teeth compared | No. of teeth which differ in one or more indices from the: Chimpanzee | Gorilla | Orang-utan | Ancient Egyptian | Australian | *Pithecanthropus* | No. of teeth compared | No. of teeth which differ in one or more indices or dimensions from the: Chimpanzee | Gorilla | Orang-utan | Ancient Egyptian | Australian | *Pithecanthropus* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Australopithecus africanus* | 2 | (2) 2 | (0) 0 | (0) 0 | (2) 2 | (2) 2 | 0 | 2 | (0) 0 | (0) 1 | (0) 0 | (0) 0 | (0) 0 | 0 | 2 | (2) 2 | (0) 1 | (0) 0 | (2) 2 | (2) 2 | 0 |
| *Australopithecus africanus* M.D. | 6 | (4) 5 | (3) 6 | (1) 2 | — | — | — | 5 | (1) 4 | (3) 4 | (2) 3 | — | — | — | 5 | (4) 5 | (3) 5 | (2) 4 | — | — | — |
| *Australopithecus prometheus* | 8 | (6) 8 | (0) 2 | (0) 0 | (8) 8 | (6) 6 | 4 | 4 | (0) 0 | (0) 0 | (0) 0 | (0) 0 | (0) 0 | 0 | 4 | (2) 4 | (0) 2 | (0) 0 | (4) 4 | (2) 2 | 1 |
| *Australopithecus prometheus* M.D. | 2 | (2) 2 | (0) 0 | (0) 0 | — | — | — | — | — — | — — | — — | — | — | — | — | — — | — — | — — | — | — | — |
| *Plesianthropus transvaalensis* | 21 | (16) 19 | (2) 5 | (0) 3 | (20) 20 | (14) 16 | 14 | 18 | (0) 0 | (0) 2 | (0) 0 | (4) 4 | (3) 4 | 3 | 18 | (15) 16 | (2) 5 | (0) 2 | (18) 18 | (13) 15 | 12 |
| *Paranthropus robustus* | 10 | (10) 10 | (1) 1 | (0) 1 | (10) 10 | (9) 10 | 7 | 10 | (0) 1 | (0) 3 | (0) 0 | (0) 0 | (0) 2 | 0 | 10 | (10) 10 | (1) 4 | (0) 1 | (10) 10 | (9) 10 | 7 |
| *Paranthropus robustus* M.D. | 4 | (2) 3 | (1) 1 | (1) 2 | — | — | — | 3 | (0) 1 | (2) 2 | (1) 1 | — | — | — | 3 | (2) 3 | (2) 2 | (1) 1 | — | — | — |
| *Proconsul africanus* | 55 | (5) 12 | (37) 46 | (23) 38 | (33) 36 | (22) 35 | 25 | 23 | (3) 6 | (1) 6 | (3) 4 | (11) 16 | (9) 13 | 13 | 23 | (4) 8 | (16) 21 | (11) 16 | (18) 19 | (11) 15 | 17 |
| *Meganthropus palæojavanicus* | 3 | (3) 3 | (1) 1 | (0) 0 | (3) 3 | (3) 3 | 2 | 2 | (0) 0 | (0) 0 | (0) 0 | (0) 0 | (0) 0 | 0 | 2 | (2) 2 | (1) 1 | (0) 0 | (2) 2 | (2) 2 | 2 |
| *Gigantopithecus blacki* | 3 | (3) 3 | (2) 3 | (3) 3 | (3) 3 | (3) 3 | 3 | 2 | (2) 2 | (0) 1 | (0) 1 | (2) 2 | (2) 2 | 2 | 2 | (2) 2 | (2) 2 | (2) 2 | (2) 2 | (2) 2 | 2 |
| *Eoanthropus dawsoni* | 2 | (0) 2 | (1) 2 | (0) 0 | (2) 2 | (0) 1 | 0 | 2 | (0) 0 | (0) 0 | (0) 0 | (2) 2 | (2) 2 | 0 | 2 | (0) 2 | (1) 2 | (0) 0 | (2) 2 | (2) 2 | 0 |

and female chimpanzee, gorilla and orang-utan. No attempt was made to subdivide the data for the ancient Egyptian, Australian aboriginal and *Pithecanthropus* according to sex.

The corrected figures naturally reveal more significant differences ($P \leqslant 0{\cdot}02$) than emerged previously. On the other hand, the general conclusions to which they point are not altered. In their overall dimensions, few of the Australopithecine teeth that have been compared differ significantly from those of the corresponding teeth of the orang (for example, only 8 of 42 teeth for which data are available to make the necessary comparisons differ, at a significance level of $P \leqslant 0{\cdot}02$, from both sexes of orang in one or more dimensions or indices tested). The correspondence was not as close with the gorilla, and least with the chimpanzee. On the other hand, *Proconsul* shows fair agreement with the chimpanzee, though not with the gorilla and orang. The majority of the comparisons of the australopithecine and the proconsul teeth with the teeth of the ancient Egyptian (a small-toothed variety of modern man), with the Australian aboriginal (a large-toothed variety), and with the fossil hominid *Pithecanthropus pekinensis*, reveal significant differences.

These observations are recorded simply as matters of fact, and regardless of their relevance, if any, to discussions of the phyletic status of the Australopithecinæ. As questions of fact they bear on many statements that have appeared in the literature, and which imply a significant difference between the overall dimensions of the australopithecine teeth and those of apes on one hand, and man on the other. Twenty-seven such statements were referred to in our previous monograph[3]. On the basis of our incorrect estimates of variance, and using the 2 per cent level of significance, we were able to corroborate only 20 per cent. Our corrected figures corroborate 50 per cent at the same level of significance.

The information given in the accompanying table is merely a summary, corresponding to that given in Tables 11–14 of our original paper[3], of the corrected results of the comparisons of individual overall dental dimensions and indices. We fully recognize that many of the dimensions that we have considered are correlated with each other, and, as shown by Fisher[4] and others, that it is desirable to use statistical methods which make allowances for this correlation. This we have tried to do in another study of primate teeth[5]. Yates and Healy[6] have, however, directed attention to the practical difficulties of the proper application of a full multivariate analysis to material of this type, and they have shown that the comparison of the means and variances of the individual measurements may, in certain circumstances, give results which are adequate to resolve questions at issue. Their method differs from that which we have followed in our summary table, in so far as they take into account the magnitude and direction of the individual differences. This we propose to do when we publish new comparisons based on our larger series of observations. The present information is provided merely to correct in concise form our previously published figures.

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# DIFFERENCES IN REACTION OF MACROMOLECULES WITH X-RAYS AND A NITROGEN MUSTARD

By Dr. P. ALEXANDER and Dr. M. FOX

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THERE is a close similarity in the biological effect produced by X-rays and the nitrogen mustards (*bis*-β-chlorethylamines)[1], and a comparative study of their effects on macromolecules was therefore undertaken. Dr. J. A. V. Butler and his colleagues have shown[2–4] that the effects of radiation, hydroxyl radicals and the nitrogen mustard HN2 [$CH_3N(CH_2CH_2Cl)_2$] on the physical properties of thymus nucleic acid are in many respects similar, and in particular that these agents bring about a marked reduction in the viscosity at low rates of shear of aqueous solutions of this material. This decrease has been tentatively attributed[4] in all these cases to degradation of the nucleic acid molecule, although in view of the complexity of the system no final conclusion concerning a decrease in molecular weight immediately after reaction with HN2 has yet been reached[5,6].

The suggestion has been made by one of us[7] that the initial effect of HN2 and compounds with similar biological activity on thymus nucleic acid may not be degradative, but that the changes in physical properties can be attributed to a change in the shape of the macromolecule. To test this hypothesis these reactions were studied in a model system in which changes in molecular weight and shape can be clearly distinguished. For this purpose the sodium salt of high molecular weight polymethacrylic acid was found suitable since its viscosity has a shear dependence similar to that of thymus nucleic acid, which it also resembles in a number of other respects[8]. On neutralizing polymethacrylic acid with a strong base the ionized carboxyl groups repel one another and in dilute solutions the molecule changes from a statistical coil to an extended chain which is responsible for the high viscosity[9].

Both X-rays and HN2 have now been found to reduce the structural viscosity of sodium polymethacrylate, and in this respect show the same effect with the model as with thymus nucleic acid.

After reaction of 0·05 per cent of polymethacrylic acid brought to *p*H 7 (that is, 60 per cent ionized) with 0·05 per cent HN2 in aqueous sodium bicarbonate, 60 per cent of the carboxyl groups of polymethacrylic acid had been esterified and in most cases one molecule of HN2 had reacted with two carboxyl groups. The viscosity of the treated polymethacrylic acid was considerably decreased, and the molecule no longer appeared to expand and contract on changing the degree of ionization. This suggests that the reduction in viscosity results from a coiling of the molecule due to intramolecular cross-linking by HN2. This point was proved by saponifying the HN2 ester formed with polyacrylic acid, when the viscosity was restored to that of a control sample (Fig. 1).

Polyacrylic acid was used instead of polymethacrylic acid in this experiment since the esters of the latter are known to be much more stable[10] than those

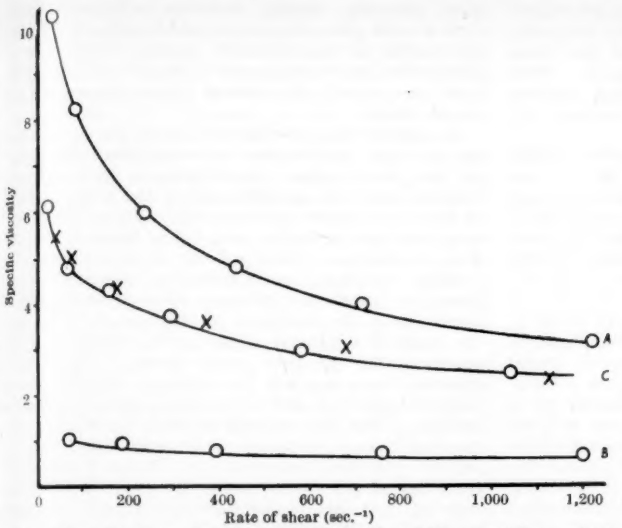


Fig. 1. Effect of HN2 on viscosity of polyacrylic acid (19° C.). *A*, 0·036 per cent polyacrylic acid in water 60 per cent neutralized; *B*, above treated with 0·16 gm. HN2 per 100 ml. in bicarbonate for 3 days and dialysed against water; *C*, as (*B*) after saponification with 0·05 *N* sodium hydroxide at 100° C. for 16 hr. followed by dialysis against water. (—*X*— denotes viscosity of non-esterified polyacrylic acid after a comparable treatment with sodium hydroxide)

of polyacrylic acid, although the reaction with HN2 was identical in both cases. The carboxyl groups of these macromolecules have a very much higher 'competition factor'[11] than those of simple carboxylic acids, since the proportion of the HN2 which had become esterified, compared with that which had been hydrolysed by water, was very much greater than expected. This observation, which is being studied further with Dr. W. C. J. Ross, may provide an explanation why HN2 and related compounds are biologically active in such low concentrations, in contrast with the results of experiments with small molecules which had indicated[11] that they would be largely destroyed by hydrolysis under these conditions.

Fig. 2 shows the effect of irradiating solutions of 60 per cent ionized polymethacrylic acid with 400-kV. X-rays on the viscosity of polymethacrylic acid. The change produced is the result of main-chain breakdown, and the number of free carboxyl groups was not detectably changed. The average molecular weight before and after irradiation was determined by measuring the viscosity of methylated polymethacrylic acid[10] (for example, irradiation of 0·14 per cent solution with 6,000 r. reduced the average molecular weight from $1{\cdot}1 \times 10^6$ to $2{\cdot}6 \times 10^5$). The decrease in viscosity produced by X-rays, especially at low rates of shear, is most pronounced in dilute solutions. This provides a highly reproducible and sensitive method for measuring dosage over a wide range by varying the polymer concentration (Fig. 2). No degradation is observed with the doses employed if the solution has been carefully deoxygenated by saturating with nitrogen or hydrogen. The effect is instantaneous and there is no slow after-effect such as is observed on irradiating nucleic acid[12]. The addition of potassium cyanide or thiourea, which are known to counteract the biological effects of X-rays[12], can greatly decrease or even completely prevent the degradation of polymethacrylic acid.

This system is now being used to screen a large number of compounds for radiation protection properties. The protective effect of these chemicals indicates that the degradation by X-rays proceeds via free radicals produced in the water. In view of the need for oxygen it is probable that a perhydroxyl and not a hydroxyl radical is responsible for the degradation. Radicals produced by irradiating hydrogen peroxide with ultra-violet light bring about a similar change in polymethacrylic acid.

In this model system, therefore, it has been established that a decrease in the viscosity, especially at low rates of shear, can be produced either by a change in the shape of the macromolecule (for example, with HN2) or by degradation (for example, with X-rays). Since polymethacrylic acid and thymus nucleic acid resemble one another in a number of respects[8], it is tempting to suggest that the action of X-rays (and free radicals) and HN2 is similar in the two polymers. Accordingly, in agreement with earlier views[13], X-rays and certain free radicals break up the thymus nucleic acid molecule. On the other hand, the initial reaction between thymus nucleic acid and HN2, which brings about the fall

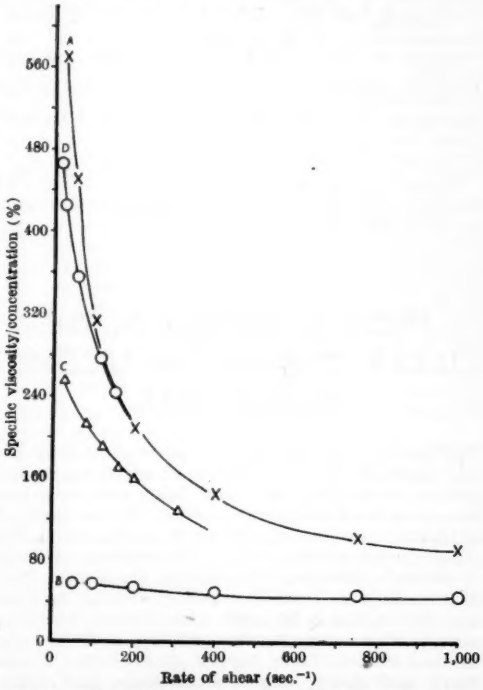


Fig. 2. Effect of 400-kV. X-rays on viscosity of 60 per cent neutralized polymethacrylic acid (19° C.) dissolved in water. *A*, 0·08 per cent polymethacrylic acid; *B*, 0·08 per cent polymethacrylic acid subjected to 4,000 r.; *C*, 0·025 per cent polymethacrylic acid subjected to 200 r.; *D*, 0·025 per cent polymethacrylic acid subjected to 50 r.

in viscosity observed immediately after reaction[8], is ascribed to a change in shape of the molecule, possibly as a result of esterification of the phosphate groups by the bi-functional reagent. Such a change in the nucleic acid molecule after reaction with HN2 has been postulated[7] to explain the decreased affinity for protamine.

Recently, pronounced differences have been found in the biological effects of X-rays and HN2[14]; for example, it is known that the two agents exert their maximal effects at different stages in the cell development. These results lend support to the view expressed here that the chemical mechanism of HN2 and X-rays is different.

We would like to express our thanks to Prof. A. Haddow for his interest and encouragement and to Mr. C. A. Greatorex (Physics Department, Royal Cancer Hospital) for carrying out the X-ray irradiation. This investigation has been assisted by a special grant from the Anna Fuller Fund and by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Feb. 7.

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## MEDICAL HISTORY IN THE U.S.S.R. DURING THE SECOND WORLD WAR

THE U.S.S.R. is the first country to have produced six or more volumes of an official medical history of the Second World War, and they have done so in a remarkably short time. On February 23, 1946, Stalin advised the Soviet Ministerial Council to organize the writing of the "Experience of Soviet Medicine in the Great War for the Fatherland 1941–1945", and the Council accordingly issued its Order No. 664 on March 26, 1946. An editorial board was set up with a comprehensive and large staff, including medical editors, chiefly regular officers of the Russian Navy and Army, expert statisticians and mathematicians, clerks, shorthand writers and typists, etc. The work is to be completed in thirty-five volumes. The price of single volumes is listed at 10 roubles for medical men and students, and 20 roubles for other persons, medical societies and institutions, with a total price for the complete work of 300 and 600 roubles to the respective groups. The editor-in-chief of the history is General-Colonel Efim I. Smirnov, who is apparently the present surgeon-general of the Soviet Army.

To assemble the necessary material for the history, the editorial board opened a competition with prizes for the best papers on experiences and scientific medical observations made during the War. A total of 454 contributions were received; 305 of these were accepted for publication, and 147 of these were given first, second and third prizes. This collection of medical experience was augmented by contributions from the naval and military services and medical institutions, the Academy of Medical Sciences and the medical institutes of individual States. In all, seventy-eight medical and ninety-four surgical diseases were studied by experts, and an index prepared which is said to contain nearly four million entries. The material assembled for writing the medical history "includes an organized file of about 30,000 photographic negatives, more than 6,500 pathological specimens, more than 30,000 exhibited objects, and about 3,000 sketches and drawings prepared at the battle-fronts".

In the U.S.S.R. the war with Germany is not regarded as a part of the Second World War; it is called "Velikaja oteôestvennaja voina"—Great War for the Fatherland. In Europe and in Asia the Russians fought until the end of the War on their native soil, so they regard it as a national struggle for self-preservation.

Lieut.-Colonel Claudius F. Mayer, of the Medical Reserve, United States Army, in May 1951 saw six published volumes of this Soviet official medical history and was impressed by their apparent standard of excellence and the high standing of the editors and contributors[1]. These latter are distinguished not only in Soviet official circles but also in international medicine and science. He quotes many of the names. The thirty-five volumes of the history are arranged in four main groups: (1) surgery, which constitutes the major portion of the history; (2) medicine (*terapia*); (3) epidemiology and hygiene; and (4) pathology of gunshot injuries. The numbers of the published volumes seen by Colonel Mayer are 4, 9, 12, 23 and 24 (in one), 26. From his account of the subjects of the six volumes, the following brief summary is taken.

Vol. 4, "Gunshot Wounds and Injuries of Skull and Brain". After a short historical review of the treatment of gunshot injuries of the head come a classification of war injuries of the head, general pathology, microflora of cerebral injuries, complications, radiodiagnostics, and general principles of treatment. The special part describes closed cranial injuries, wounds of soft tissues of the head, non-perforating and perforating injuries and their complications.

Vol. 9, "Injuries of the Chest". A short history of the treatment of gunshot injuries of the chest is followed by chapters on the classification and frequency of chest wounds, complications, prognosis, principles of evacuation, radiodiagnosis of chest wounds and foreign bodies, injuries of the heart and large vessels, of the lungs and pleura, traumatic empyema, contusions of the lung, etc. The special part has five chapters on perforating and non-perforating injuries of the chest, foreign bodies of pleura and lung, injuries of the mediastinum and of

its organs (trachea, œsophagus, thoracic duct, etc.), and injuries of the large blood vessels.

Vol. 12, "Gunshot Wounds and Injuries of the Abdomen". The four chapters of the general part describe the history of treatment before the War, classification and frequency, general characteristics, complications, first aid and surgical treatment of abdominal wounds. The special part deals in nine chapters with non-perforating and perforating injuries of (*a*) hollow and (*b*) parenchymatous organs, association of abdominal injuries with those of the urinary organs, thoraco-abdominal wounds, complications, closed injuries of the abdomen, including injuries produced by blasts and water waves, and prognosis of abdominal injuries. Each chapter includes also subsections on pathogenesis, symptomatology, statistics, and treatment of the particular type of injury.

Vol. 23, "Diseases of the Stomach". This volume deals with (*a*) gastritis and (*b*) ulcerative diseases of the stomach (peptic ulcer). The frequency of peptic ulcers was less and less towards the end of the War —only 1 per cent. This is in striking contrast to the British experience on the whole. Vol. 24, "Diseases of Liver; Acute Hepatitis". This volume of 119 pages is bound with the preceding one. Its three chapters describe: epidemic hepatitis or the Botkin disease; the 'salvarsan-syphilitic' hepatitis; and ictero-hæmorrhagic leptospirasis or the Weil–Vasiliev disease.

Vol. 26, "Nervous Diseases". In six chapters, this volume treats of the various forms of psycho-neurosis, the diseases of the peripheral nervous system, the types of polyneuritis, including those of avitaminotic origin, vascular diseases of the brain and affections of toxic origin. One chapter deals with epilepsy, and another of importance on tick-borne encephalitis.

For further observations on these volumes, including the quotation of some interesting statistics, Colonel Mayer's paper should be consulted[1]. Apart from certain criticisms on indexing and absence of detailed references, he considers that "our Russian medico-military colleagues have done their best in describing their own experiences for the erudition of the medical world".

The Soviet official medical history appears to be planned on an encyclopædic scale and to include a great deal of clinical information which the editors of the projected "British Official Medical History of the Second World War" consider are already available in the British standard text-books. Consequently, the two clinical volumes on medicine and surgery, which are shortly to be published, deal in a succinct form with the advances made in these subjects during the Second World War, but leave out much which the Soviet editors, no doubt quite rightly from their point of view, have included in their massive volumes. The latter also include copious case-histories which for the most part the British editors have omitted. A good portion of the British history is devoted to the administration and organization of the different Services, and the campaigns are dealt with in more detail. Further volumes of the Soviet history may cover the last-mentioned points, but the impression one gets at present is that the Soviet medical history is chiefly clinical in character. To say this does not detract in any way from its importance and its value as a contribution to medical and surgical progress as seen under modern war conditions.

ARTHUR MACNALTY

[1] Mayer, C. F., "Medical History of the Russo-German War, 1941–1945", *The Military Surgeon*, **109**, No. 3 (September 1951).

# CHAIRS OF CHEMISTRY IN IRELAND

By PROF. WESLEY COCKER and PROF. T. S. WHEELER

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THE recent communications by Prof. Alex. Findlay[1] and of Prof. A. R. Todd[2] with reference to the "earliest chair of chemistry, *tout simple*" in Scotland and England, raises a similar issue in regard to Ireland. Two chairs only need to be considered; both were established by the Irish Parliament, one in Trinity College, Dublin, in 1785, and the other in the Dublin (now Royal Dublin) Society in 1796. The chairs in Belfast, Cork and Galway were formally established about 1845.

The teaching of medicine in the University of Dublin (Trinity College) began about 1604; but it was not until about 1711 that a lectureship in chemistry was established and Dr. Robert Griffith appointed to it. He and his successors in the lectureship were practising physicians with little interest in chemistry. Dr. Robert Perceval, the first University professor of chemistry, appointed in 1785, published a few papers in chemistry, but is remembered as a distinguished physician who did much to organize clinical teaching in Dublin. His successor, Dr. Francis Barker, appointed in 1808, established the first fever hospital in Ireland. Dr. James Apjohn, F.R.S., who followed in 1850, after completing his medical studies devoted himself to science. He was interested in geology and mineralogy as well as in chemistry and physics, and may be regarded as the first chemist to occupy the chair. Dr. James Emerson Reynolds, F.R.S., the incumbent from 1875 until 1903, is well known for his synthesis of thiourea. He was president of the Chemical Society during 1901–3. Prof. Sydney Young, F.R.S., his successor, was the first non-medical holder of the chair.

The Royal College of Physicians of Ireland must still concur in appointments to the University chair of chemistry. In 1922, the Board of Trinity College established the chair of general chemistry in order that it need not consult others about the appointment of the professor of chemistry. It has, so far, been the practice for the same person to hold the two chairs, for it is the chair of general chemistry which carries with it the directorship of the Department of Chemistry and the remuneration. The University professor is appointed or reappointed every seven years.

The oldest chair of chemistry in Ireland always dissociated from medicine would appear to be that established by the Irish Parliament in the Dublin Society in 1796. The relevant Act (36 George III, Chapter 16) provided funds to pay a salary not exceeding one hundred and fifty pounds a year to Mr. William Higgins or such other professor of mineralogy or chemistry as the Society should from time to time appoint. Higgins was styled professor of chemistry and mineralogy, but devoted himself mainly to teaching and practical work in chemistry, as he was not a mineralogist. In 1812 a separate chair of mineralogy was established. In 1854 the chemistry chair was transferred to the Museum of Irish Industry, founded by the Government about 1845 as a result of the efforts of the distinguished

Irish chemist and administrator, Sir Robert Kane, to arouse interest in the application of science to industry. In 1867 the Museum became the Royal College of Science for Ireland. This College was transferred to University College, Dublin, in 1926 and the chair of chemistry merged in that set up by Cardinal Newman in the Irish Catholic University in 1856.

The occupants of the chair established in 1796 were William Higgins, F.R.S. (1796–1825); Edmund Davy, F.R.S. (1826–54); chair transferred to the Museum of Irish Industry: W. K. Sullivan (1854–67); chair transferred to the Royal College of Science for Ireland: W. K. Sullivan (1867–73); Robert Galloway (1873–79); Sir Walter Hartley, F.R.S. (1879–1911); Sir Gilbert Morgan, F.R.S. (1912–16); W. E. Adeney (1916–23). The chair was then left vacant pending transfer to University College, Dublin. It will be seen that this chair is nearly as old as the oldest in Scotland (Aberdeen, 1793), but is long antedated by that at Cambridge (1702).

[1] [*Nature*, **169**, 160 (1952).
[2] *Nature*, **169**, 292 (1952).

## TERCENTENARY OF THE LEOPOLDINA ACADEMY, HALLE

THE Leopoldina Academy (Deutsche Akademie der Naturforscher) at Halle (Saale), in the East Zone of Germany, celebrated its tercentenary during February 16–17. The University of Halle co-operated closely with the Academy throughout the proceedings. Addresses of congratulation were received from the Royal Society, the Cambridge Philosophical Society and the Royal Society of Edinburgh.

After addresses of welcome by the first vice-president, Prof. Otto Schlüter, and others, a historical account of the Academy was given by Prof. Rudolph Zaunick, of Dresden. The programme of future work laid down in this connexion is primarily to resume and speed up publication projects in abeyance since the War. The Academy's journal, the *Nova Acta Leopoldina*, has completed Vol. 14 (New Series) with the appearance of Heft 5, and will continue. The Commentary on Euclid Book I by Proclus Diadochus (A.D. 410–485) has appeared. A complete edition is in progress, in fourteen volumes of text with commentary, of all Goethe's scientific works, of which the Academy has already brought out a very large index. These and other beautifully produced publications were on view in the Library of the Leopoldina Academy. Losses of valuable records and collections were, however, also noted.

At the scientific session on the second day, Prof. Hans Georg Kienle, of Heidelberg, discussed cosmical theory of the past fifty years. Prof. Max Bürger, of Leipzig, was too ill to give his lecture, "Die Lebensschicksale des menschlichen Herzens", and his place was taken by Dr. Max Ratschow, of Halle-Wittenberg, who spoke on problems of old age ("Über die Verhütung von Alters- und Aufbrauchsschäden unter besonderer Rücksichtigung der hormonalen Therapie"). Ageing, which generally speaking is a drying-up process, connected with a reduced water-absorption and water-retention capacity of tissues, is largely caused through disturbance of hormonal balance, and a natural approach is to redress this balance as far as possible. Prof. Hans Theo Schreus, of Düsseldorf, under the title "Besondere Gesichtspunkte bei der Behandlung mit Chemotherapeutics und Antibiotices von Geschlechtskrankheiten", gave an account of his researches into the treatment of venereal diseases, with special reference to the increase in bacterial resistance against penicillin during the years 1949–51. He has studied in detail the effect of combining the chemotherapeutics terramycin, streptomycin, penicillin with one another and with other antibiotics, and has tabulated the correlation coefficients obtained. He also described the results in serum reactions of saturation treatment or short-term treatment with penicillin–bismuth–salvarsan.

Finally, Prof. Kurt Mothes, of Halle-Gatersleben, gave an address entitled "Die stoffliche Organisation der Pflanze". His theme was the lack of parallelism between complexity of organization and multiplicity of chemical substances in living organisms. Metabolic products found in the more complex organisms, such as animal bodies, in particular the human body, are neither very numerous nor very complex; thousands of other substances are present in lower forms of life, such as plants and micro-organisms. One reason for the variety of products found in lower organisms may be their lack of secretory mechanism, which favours storage, whereas, for the animal body, rapid excretion is typical. Referring to the virus world, Prof. Mothes suggested that not only do viruses vary considerably in size, but also many may exist besides those that manifest themselves by pathological effects.

The occasion was used further to honour the memory of Prof. Emil Abderhalden, whose place as president has not yet been filled.

Social gatherings forming part of the celebrations included a reception by members of the East Zone Government in Berlin, one by the local Government of Sachsen-Anhalt, and musical and dramatic performances.

## INDIAN SCIENCE CONGRESS

### THIRTY-NINTH SESSION

THE Indian Science Congress has been holding its annual sessions since the year 1914 at different towns and cities of India with the view of enabling eminent men of science of India as well as from abroad to meet on a common platform of intellectual kinship and to keep abreast of the times in discussions of scientific problems. The 1952 session was held early in January in Calcutta, which has always been one of the nerve-centres of India's intellectual life. The meeting-place was the historic compound of the Presidency College, Calcutta, which also saw the birth of the Indian Science Congress thirty-nine years ago.

In a spectacular pandal bedecked with floral and artistic designs and packed to its capacity of more than six thousand people, the session was opened by the chanting of Vedic hymns and the recitation of *Vande Mataram*. H.E. Dr. H. C. Mukerji, Governor of West Bengal, welcomed the distinguished gathering of scientific workers who had come to attend the session; and he urged that, although imported from the West, the modern scientific spirit should not be looked at askance by the people of India. In the course

of another address, Mr. Justice S. N. Banerji, vice-chancellor of the University of Calcutta and chairman of the Reception Committee for the meeting, exhorted scientific men to bring their researches to bear upon national progress and international peace, and suggested that much could be done by the collective effort of world scientists to prevent the manufacture of destructive weapons. The Honourable Dr. B. C. Roy, Chief Minister of West Bengal, inaugurating the session, laid stress on the humanitarian aspect of scientific thought and said that both the man of science and the administrator should think in terms of the human mind for the progress of the world.

Then the Honourable Shri Jawaharlal Nehru, Prime Minister of India, delivered an address, in the course of which he called upon scientific workers of every rank and level to lend him their active co-operation in the solution of the gigantic problems that are facing the teeming millions of India. Mentioning that the setting up of national laboratories was a matter of pride for the people of India, he observed that the masses ought to realize the importance of the role that scientific men have to take in the building up of a truly modern India.

Dr. J. N. Mukherji, director of the Central Building Research Institute, Roorkee, the president-elect of the session, in his presidential address entitled "Science and our Problems: Science and the Yield per Acre", urged scientific workers to ask themselves how far they are wielding their influence in the planning and implementation of the reconstruction programmes of the newly born Indian Republic. He added that planning is no less imperative for successful scientific research and training than for any other undertaking. Dr. Mukherji disapproved of the pursuit of science with a purely academic object in virtual isolation from the wider spheres of industry and agriculture. The improvement of social and economic conditions, he pointed out, would depend to a large extent upon the dissemination of accurate scientific knowledge. He recommended the formation of scientific societies for the maintenance of a proper standard of research, in the absence of which the wheels of national progress would be clogged.

The session was attended by about forty distinguished men of science from Great Britain, the United States, Switzerland, Denmark, West Germany, the U.S.S.R., Australia and Japan, among whom were Prof. J. B. S. Haldane (Weldon professor of biometry, University College, London), Prof. M. Heidelberger (professor of biochemistry in Columbia University, New York), Prof. C. B. Fawcett (emeritus professor of geography in the University of London), and Dr. E. C. Bullard (director of the National Physical Laboratory, Teddington). The presence of these visitors was a source of considerable enthusiasm and inspiration for their Indian colleagues.

The Congress met in thirteen sections: mathematics, statistics, botany, anthropology and archæology, chemistry, geology and geography, medical and veterinary sciences, physics, engineering and metallurgy, physiology, psychology and educational sciences, agricultural sciences, and zoology and entomology.

Among the presidential addresses of great interest and popularity were, "Some Aspects of Crystal Magnetism" (Physics Section), "Etiology of Cancer" (Medical and Veterinary Sciences Section), "Some Recent Methods of Solving Problems of Equilibrium and Vibration" (Mathematics Section), and "Technical Education" (Engineering and Metallurgy Section). The presidential address at the anniversary meeting of the National Institute of Sciences of India was delivered by Dr. S. L. Hora on "Adaptation and Evolution".

During the sectional meetings some seven hundred research papers communicated by scholars all over the country were read and discussed. A volume of abstracts of these papers was published and distributed by the Association to help the smooth progress of discussions.

Among the significant symposia held during the session mention may be made of the following: "Soil Research in India", organized by the National Institute of Sciences of India and opened by Dr. J. N. Mukherji, "Fermentation Technology" (Chemistry Section), "Is Evolution Purposive?" (Botany and Zoology Sections), "Family Types and Changes in the Family of India" (Anthropology and Psychology Sections), "Geography of Crop Plants" (Botany Section), "Refugee Problem in Bengal" (Anthropology Section), "River Control" (Engineering and Metallurgy Section), and "Mathematical Teaching and Research in India", opened by Dr. B. N. Prasad. In view of the great importance of this subject, it has been agreed that the symposium will be continued from year to year for arriving at definite conclusions about the ways and means of reforming mathematical teaching and research in India.

A number of popular lectures on various topics were delivered by some of the foreign visitors and others. Some of them were: "Relation of Biology with other Sciences", by Prof. J. B. S. Haldane; "The Ocean Floor", by Dr. E. C. Bullard; "Antibiotics", by Dr. J. H. Kane; "Story of Monazite Sands", by Sir Shanti Bhatnagar; "Fisheries of South-East Asia", by Dr. G. L. Kesteven; and "Defence Sciences and their Organization", by Dr. D. S. Kothari.

One of the most instructive and informative features of the session was the Science Exhibition, at which exhibits from various scientific firms were displayed. During the evenings entertainment in the form of dance-dramas, Indian dances and music was offered by local artists and amateurs of the colleges and the University of Calcutta. Another interesting feature of the session was the arrangement for scientific excursions to local places of interest and beauty spots and also visits to the Tata Iron and Steel Works and the National Metallurgical Laboratory of Jamshedpur, Chittaranjan Locomotive Works, Damodar Valley Corporation, Mayurakshi Reservoir Project and the Indian Institute of Technology, Kharagpur.

To synchronize with the annual session of the Indian Science Congress a large number of scientific associations and societies like the National Institute of Sciences of India, the Indian Physical Society, the Indian Chemical Society, and many others held their annual meetings. The Geological, Mining and Metallurgical Society of India also celebrated its silver jubilee this year.

At the general meeting of the Science Congress, Dr. D. M. Bose, director of the Bose Research Institute of Calcutta, was elected president of its fortieth session, which will be held at Lucknow in January 1953. Dr. B. N. Prasad, University of Allahabad, and Dr. S. R. Sen Gupta, Bengal Engineering College, Shibpur, were elected general secretaries, and Prof. P. C. Mahalanobis was elected treasurer.

B. N. Prasad

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Theory of Superconductivity

The connexion between superconductivity and lattice vibrations seems now well established through the discovery of the dependence of the transition temperature on isotope mass[1]; and through the investigations of Fröhlich and of Bardeen[2] and their followers—preceded by the pioneer work of F. London—the explanation of this puzzling phenomenon by means of the principles of quantum theory seems well under way. There are still difficulties, however, and recently Drell[3] has concluded that the interaction between electrons and phonons is not sufficient to produce the energy gap or small electron mass at the Fermi surface predicted by the calculations of Fröhlich and Bardeen. On the other hand, the strong degeneracy of the electron-phonon system with corresponding resonances gives rise to such mathematical complication that Drell's conclusion seems also open to doubt[4]. Therefore, some independent check of the main features of the theory would seem desirable.

As an attempt in this direction I have calculated the probability for the emission of phonons by an electron coupled to sound waves and moving with a velocity greater than the velocity of the waves; as is the case with electrons in metals with energies greater than the Fermi surface. The background for this calculation, as for those of Fröhlich and Bardeen, is London's remark that superconductivity will occur when the electrons are only slightly disturbed by a magnetic field. The stationary states of the system being mixtures of different combinations of undisturbed electron and phonon states, we may express this by saying that the states energetically in the neighbourhood of the normal state must contain only a small percentage of electron excitation.

Now this property of the stationary states in the neighbourhood of the normal state will imply that an electron of energy corresponding to an excitation within the range in question will radiate phonons with so large a probability that its life-time is shorter than, or of the same order of magnitude as, the time required to determine its energy with an accuracy $\Delta\varepsilon$ of the order of magnitude of the excitation energy $\varepsilon$ itself. Thus, we shall expect superconductivity to occur when, and only when, the $\Delta\varepsilon$ calculated from the life-time is larger than $\varepsilon$ for small excitations, while for higher excitations $\Delta\varepsilon/\varepsilon$ decreases to smaller and smaller values, the transition temperature $T_c$ being of the order of magnitude $\varepsilon/\varkappa$ (where $\varkappa$ is the Boltzmann constant) for that excitation for which $\Delta\varepsilon = \varepsilon$.

The sound radiation of an electron under these conditions has, as is easily seen, the same 'bow wave' character as that from a fast-moving projectile or the Cerenkov radiation from an electric particle moving faster than the phase velocity of light. In fact, the degeneracy of the electron-phonon system corresponds directly to the well-known condition governing the angular distribution of a 'bow wave' in three-dimensional space. Using the same model as Bloch in his theory of the electric conductivity of metals[5] for the interaction between electrons and sound waves, we get, for excitation energies small compared to the electron energy at the Fermi surface,

$$\frac{\Delta\varepsilon}{\varepsilon} = \frac{hC^2}{48\pi m^2 v\sigma s^4}\,\varepsilon^2, \qquad (1)$$

where $h$ is Planck's constant, $C$ the quantity given by Bloch (*l.c.*, formula (64), approximately equal to $10^{16}$ cm.$^{-2}$), $m$ the electron mass, $v$ the electron velocity at the Fermi surface, $\sigma$ the density of the metal and $s$ the velocity of sound. Since $\Delta\varepsilon/\varepsilon$ according to this formula increases with increasing $\varepsilon$ and, moreover, is small compared to unity—as is seen when reasonable values are assumed for the different quantities—for excitations of the order of magnitude $\varkappa T_c$ we reach the conclusion that the Bloch model will not give rise to superconductivity. This result, which is in conformity with Drell's statement, depends essentially on the assumption that the potential governing the motion of the electron is a linear function of the displacement vector *at the same point*. This assumption is certainly justified when, as in the problem of ordinary electric conduction, the main effect is due to scattering of the electrons by the separate atoms of the lattice and does not depend on small long-range changes of the potential.

In an attempt to save the electron-phonon theory of superconductivity, we shall now assume that a small part of the electron density remains stationary during the vibrations, so that on the average the moving atoms carry a positive excess charge $\alpha e$, where $\alpha$ is a small fraction and $e$ the elementary electric charge. Then we obtain the following expression for the probability $dP$ for the emission of a phonon of energy between $\varepsilon$ and $\varepsilon + d\varepsilon$ per unit time:

$$dP = N\,\frac{4\pi\alpha^2 e^4}{Mv}\,\frac{d\varepsilon}{\varepsilon^2}, \qquad (2)$$

where $N$ is the number of atoms per unit volume, $M$ the mass of the atom and $v$ the electron velocity at the top of the Fermi distribution. This expression clearly leads to a breakdown in the infra-red, which demands closer investigation. Here we shall assume that the main limitation to the emission of low-energy quanta is due to radiation damping, and provisionally we shall replace the denominator $\varepsilon^2$ by $\varepsilon^2 + (\Delta\varepsilon)^2$, which, if not correct, would probably at least give the right order of magnitude. Putting

$$\varepsilon_0 = \alpha e^2\left(\frac{2hN}{Mv}\right)^{1/2}, \qquad (3)$$

we get thus

$$\Delta\varepsilon = \frac{\varepsilon_0^2}{\Delta\varepsilon}\tan^{-1}\frac{\varepsilon}{\Delta\varepsilon}. \qquad (4)$$

This formula shows that $\Delta\varepsilon/\varepsilon$ decreases from infinity to zero, when $\varepsilon$ increases from zero to infinity, taking the value 1 for $\varepsilon = \frac{1}{2}\varepsilon_0\sqrt{\pi}$. We shall therefore expect superconductivity for energy states corresponding to excitations less than $\sim \varepsilon_0$, so that

$$\varkappa T_c \simeq \varepsilon_0. \qquad (5)$$

We see from (3) that the proportionality of $T_c$ to $M^{-1/2}$ follows in this way. To see if the order of magnitude is reasonable, we can use (3) and (5) to calculate $\alpha$ from the experimental values of $T_c$. In this way $\alpha$ comes out to be of the order 0·001–0·01. We shall not enter here on the question of the theoretical

foundation of the model proposed. The details of the calculations will be published elsewhere.

O. KLEIN

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Stockholms Högskola. Jan. 9.

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## X-Ray Line-Broadening from Cold-worked Iron

MANY experiments have been carried out in different laboratories in recent years to determine whether particle size or lattice distortion is the predominant cause of X-ray line-broadening from cold-worked metals[1–6]. These have produced conflicting results, even when subjected to the critical test of varying wave-lengths of the X-radiation[4,6].

In any new attack on the problem it is therefore essential to inquire critically and carefully into any assumptions which may have been made in previous work. The two most doubtful are: first, the methods employed for determination of the true integral breadth $\beta$ due to the effect of cold-work alone, and secondly, the appropriate values of Young's modulus $E_{hkl}$ to be used for testing the validity of the non-uniform lattice distortion hypothesis for elastically anisotropic metals[3,7]. A further complicating factor has been that some workers have examined cold-worked metals in the bulk state, whereas others have used filings, with apparently diverse results.

In consequence, experiments on cold-worked iron have been carried out in the Defence Research Laboratories, Melbourne, with four main points in mind.

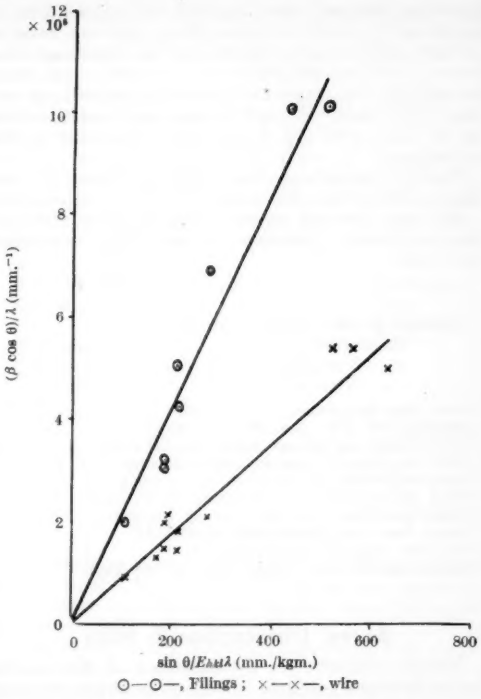
(1) A development of Stokes's method[8] has been used for determining $\beta$, to avoid any assumptions about the form of the intensity distribution across the diffraction lines.

(2) Preliminary experiments in the elastic range were carried out on the material for several sets of $(hkl)$ planes to determine experimentally the appropriate values of $E_{hkl}$. It was found that these agreed within $\pm$ 5 per cent with the corresponding averages of values calculated on the assumptions of either constant stress or constant strain in the polycrystalline aggregate. Since, in practice, it was not possible to determine the experimental values of Young's modulus for all the sets of planes involved in the line-broadening experiments, the calculated mean values were used throughout in the subsequent analysis.

(3) Both filings and bulk metal were examined under similar experimental conditions and with identical analytical procedures for assessing the results, to determine whether any radical difference in the nature of the deformation process could be detected.

(4) Lastly, by paying particular attention to experimental technique, it was hoped to obtain accurate measurements of line breadths over a fairly wide range of $\theta$ and $\lambda$ values.

The material used was ingot iron of 99·95 per cent purity. Specimens in wire form were examined in a precision Debye–Scherrer camera, first in the strain-free state and then after having been stressed in tension to various stages in the plastic range. Similar experiments were carried out using cold-worked and annealed filings. Crystal-reflected cobalt, chromium and iron monochromatic radiations and filtered molybdenum radiation were employed. The use of intensifying screens was avoided in all exposures, as subsidiary experiments indicated that they could produce most misleading results.




A full account of the work will be published elsewhere; but some typical results are illustrated in the accompanying graph, which has been plotted in the manner suggested by Hall[9]. These refer to filings and to a wire pre-stressed to 42·6 kgm./mm.² (27·1 tons/in.²). Hall's method suffers from the disadvantage that a linear relationship will only be obtained if the broadening due to particle size and distortion are additive, which in general will not be true. However, if one effect largely predominates, the departure from linearity will not be serious.

As is usual in these graphs, the scatter is appreciable, but the lines of best fit pass very close to the origin in each case. It therefore appears that, at least for iron, lattice distortion is by far the predominant cause of line-broadening, and that there is no essential difference in the deformation process between filings and stressed wires.

Two further points support these results. First, for all our results, the relationships between the Fourier coefficients and frequency for the true broadening profile approximate closely to the shape of error curves. Warren and Averbach[9] have pointed out that this would be expected if lattice distortion were the predominant effect. Secondly, in agreement with Wood and Rachinger[5], it has been found that the breadths from filings are larger than the corresponding values from the bulk metal (wire) strained to give maximum broadening, the ratio being about 2·5. However, instead of interpreting this as a measure of the difference between particle size and

distortion effects, it can equally well, in principle, be attributed to lattice strains alone. On the basis of certain assumptions, which will be described elsewhere, it has been calculated that, for lattice-distortion broadening, the ratio of the breadths from filings and from bulk metal strained in uniaxial tension should be of the order of 2–2·5 for corresponding *hkl* reflexions.

Further analysis of the results in terms of line-shapes rather than line-breadths is now in progress.

We are indebted to the Chief Scientist, Department of Supply, Australia, for permission to publish this letter.

J. H. Auld
R. I. Garrod

Defence Research Laboratories,
Melbourne, Victoria,
Australia.
Oct. 31.

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## Screw Dislocations in Mica

Direct evidence for the existence of dislocations has so far been confined to known examples of spiral growth: beryl[1], an *n*-paraffin[2], silicon carbide[3,4] and cadmium iodide[5]. We have now experimental evidence for the existence of screw dislocations in mica (muscovite).

Mica cleavage faces have been intensively studied by S. Tolansky[6,7], who proved the existence of steps on such surfaces by means of multiple-beam interferometry. These steps have heights which are, in general, whole multiples of 20 A., in some cases[8] 10 A. On all the interferograms published so far, they run all over the surface. This is, in fact, nearly always so. We have now observed on a carefully cleaved sheet of mica a step ending in the middle of the face. The accompanying photograph (Fig. 1) is a reflexion Fizeau interferogram of this face ($\lambda = 5470$ A.), the inset being an enlargement of the interesting part. From the fringe displacement the step-height was estimated to be $H = \pm 140$ A. We made sure that the step was not due to the optical flat. The reference flat could be arranged in such a way that the fringes

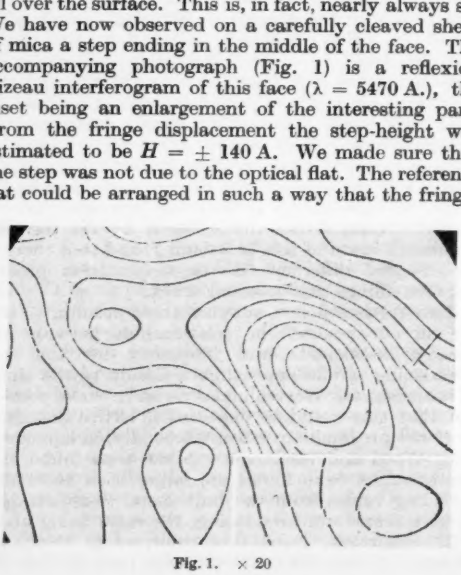

Fig. 1. × 20

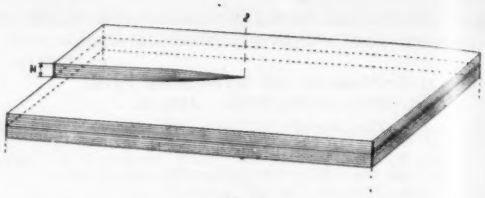

Fig. 2

surrounded the end-point of the step, so that we could conclude unambiguously that the step ended.

The surface topography corresponding to the fringe pattern is shown in Fig. 2. It is clear that the point where the step ends must be considered as the point where a screw dislocation emerges from the surface. As the step-height is equal to probably some seven times the identity distance, the screw dislocation has a resultant Burgers vector of some seven unit cells long. Dislocations having total strengths of the same order of magnitude are not exceptional, for example, in silicon carbide, as can be proved by measuring the step-heights of growth spirals on these crystals. Presumably, in this case also, the screw dislocation was generated during growth of the crystal and made it grow helicoidally, following the Frank mechanism[9]. As in mica the binding forces between sheets are much weaker than between ions in the sheet, it is to be expected that cleavage will proceed along the same plane (that is, the plane containing the potassium ions), even when passing a screw dislocation line. A coincidence of circumstances is, however, necessary to show the phenomenon: (1) a screw dislocation of suitable strength to produce a visible step must be present; (2) cleavage must take place without destroying the dislocation.

This explains why the phenomenon has hitherto escaped observation, and why a considerable number of pieces of mica had to be cleaved to obtain a photograph showing clear evidence.

The observations recorded here suggest a possible explanation for the various types of mica structures observed by S. B. Hendricks[10], as well as for the chlorite structures. An account of interferometric observations on chlorites and sandwich structures of the chlorite type will be given elsewhere, in more detail, in collaboration with Prof. W. Dekeyser, to whom I am indebted for the remarks on the structure of mica and for suggesting this investigation. I also acknowledge the receipt of support from the C.N.B.C.P.M.

*Note added in proof.* Since this communication was submitted for publication, we have been able to observe growth spirals on biotite crystals[11] (var. meroxene, from Vesuvius) which give a direct proof of the preceding deductions.

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## Band Spectra in the Schumann Region of NO and $N_2^+$ with Enriched Nitrogen-15

In connexion with the investigation of a new band system of the NO molecule ($B'-X^2\Pi$)[1] we photographed the emission spectra of $^{15}NO$-gas. For the preparation of this gas we are very grateful to Prof. Clusius. The region investigated extends from 1300 to 2200 A. The spectrograph used was a 1-m. vacuum grating (8 A./mm. dispersion). An uncondensed discharge of 250 m.amp. through a tube 20 cm. in length and 4 mm. in diameter, containing circulating helium at a pressure of 4 mm. mercury, formed the source of light. To this a small amount of $^{15}NO$ was added. We observed bands of NO and $N_2^+$. A provisional measurement of the isotope splittings has been carried out.

(*a*) NO. *ε-bands:* Table 1 gives the observed and calculated isotope doublets and shows definitely that the ε-bands belong to a separate system. Herzberg and Mundie's[2] suggestion that the ε-bands might be a continuation of the γ-system with vibrational levels $v' \geqslant 4$ is therefore no longer valid.

Table 1. Isotope Shifts, $\Delta\nu = \nu^{15} - \nu$(cm.$^{-1}$) in ε-Bands of NO

| $v'$, $v''$ | 1·0 | | 0·1 | | 0·2 | |
|---|---|---|---|---|---|---|
| Head | obs. | calc. | obs. | calc. | obs. | calc. |
| $Q_1$ | − 44·1 | | | | + 60·0 | |
| $P_1$ | − 42·6 | | | | + 60·9 | |
| $Q_2$ | − 44·0 | − 43·7 | + 28·7 | + 29·3 | + 59·8 | + 61·4 |
| $P_2$ | − 43·9 | | + 31·1 | | + 60·7 | |

*β′-bands:* The isotope shifts of the bands of this new system confirm the analysis already published[1]: $B'$-term: $\nu_e = 60{,}366$ cm.$^{-1}$, $\omega_e = 1{,}216$ cm.$^{-1}$, $x_e\omega_e = 16{\cdot}4$ cm.$^{-1}$.

Table 2. Isotope Shifts, $\Delta\nu$ of $N_2^+$-Bands (System $C - X$).
$\Delta\nu^{I} = \nu(^{14}N^{15}N) - \nu(^{14}N_2)$ (cm.$^{-1}$)
$\Delta\nu^{II} = \nu(^{15}N_2) - \nu(^{14}N_2)$ (cm.$^{-1}$)

| Watson-Koontz | | Setlow | | | Observed values | |
|---|---|---|---|---|---|---|
| $v'$, $v''$ | $\Delta\nu^{I}$ | $v'$, $v''$ | $\Delta\nu^{I}$ | $\Delta\nu^{II}$ | $\Delta\nu^{I}$ | $\Delta\nu^{II}$ |
| 8,10 | + 42·9 | 3,10 | + 210·1 | + 424·8 | + 210 | + 417 |
| 9,11 | + 37·5 | 4,11 | + 203·4 | + 411·5 | + 203 | + 408 |
| 10,12 | + 31·4 | 5,12 | + 196·5 | + 397·7 | + 192 | + 393 |
| 11,13 | + 25·0 | 6,13 | + 190·1 | | + 189 | |
| 8,9 | + 17·2 | 3,9 | + 184·4 | | + 182 | |
| 9,10 | + 13·0 | 4,10 | + 178·9 | + 361·8 | + 174 | + 355 |
| 10,11 | + 8·3 | 5,11 | + 173·4 | + 350·9 | + 169 | + 346 |
| 11,12 | + 2·9 | 6,12 | + 168·0 | | + 168 | |
| 8,8 | − 9·6 | 3,8 | + 157·6 | | + 155 | |

(*b*) $N_2^+$. Table 2 contains both the isotope displacements observed in the $C - X$ system and the theoretical values for the analysis of Watson and Koontz[3] on one hand, and the analysis of Setlow[4] on the other. It is seen that Setlow's analysis, originally based only upon the intensity distribution, is the correct one. The following data are now calculated for the $C^2\Sigma$-level of $N_2^+$:

$\nu_e = 64{,}620$ cm.$^{-1}$, $\omega_e = 2{,}065$ cm.$^{-1}$, $x_e\omega_e = 7{\cdot}7$ cm.$^{-1}$, $y_e\omega_e = -0{\cdot}56$ cm.$^{-1}$.

Table 3. ($\nu$, Heads of Isotope Band Observed)

| $v'$ \ $v''$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 0 | 73,087 | 70,751 | 68,437[a] | 66,161[a] | 63,910 | 61,704[a] | 59,517 |
| | 2,336 | 2,314 | 2,276 | 2,251 | 2,206 | 2,187 | |
| 1 | | 1,559 | 1,562 | | | | |
| | | 72,310 | 69,999 | | | | |
| | | 2,311 | | | | | |

(*c*) *New system.* On the same spectrogram a new system was found. The wave-numbers of the heads are shown in Table 3. All bands are degraded to the red.

The analysis is based on the observed isotope shifts. The vibrational frequency of the lower level agrees with the frequency of the $X^1\Sigma$ level of the nitrogen molecule as well as with the frequency of the $A^3\Sigma$ level of the nitric oxide molecule. Since neither alternation of intensity in the rotational structure nor heads of nitrogen-15 ($^{15}N_2$) have been observed, no decision between these alternatives is possible at present.

Further details will soon be reported elsewhere.

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## Tellurite Glasses

It has been noted previously[1] that the elements which, in the form of their oxides, are generally regarded as excellent glass formers have values of electronegativity on the Pauling scale[2] of 1·7–2·1. For example, boron, silicon, phosphorus and germanium with electronegativity values of 2·0, 1·8, 2·1 and 1·7 form borate, silicate, phosphate and germanate glasses. In addition to these elements, others with values in the same range, according to Pauling, are arsenic and antimony (which form, for example, $As_2O_3$ and $Sb_2O_3$ glasses) and tellurium with an electronegativity value of 2·1, that is, the same as for phosphorus. These facts lead one to consider whether tellurium oxides or the tellurites or tellurates form glasses.

So far as I am aware, technologists have so far been quite unaware of the possibility of preparing tellurite and tellurate glasses, and yet a search of the literature soon revealed that Berzelius[3] had mentioned that clear, colourless glasses could be prepared from the molten tetratellurites of the alkali metals and of barium. More recently, Lenher and Wolesensky[4] confirmed the glass-making properties of sodium and potassium tellurites. Those observations, only briefly recorded in papers of wider chemical interest, appear to have escaped the attention of technologists.

An investigation of tellurite glasses was thought to be worth while, not only for its fundamental interest, but also because it could be expected that these glasses would have physical properties of value. For example, it could be estimated from the known cation radius of $Te^{4+}$ (0·84 A. in its oxide) that the partial refractivity of tellurium oxide ($TeO_2$) in glass would be quite high[5] and that tellurite glasses would therefore, have much higher refractive indices than corresponding silicate, borate, phosphate and germanate glasses.

The first glasses I studied were in the systems BaO—$TeO_2$ and PbO — $TeO_2$. They were found to

have unusual physical properties. For example, a glass having the molecular formula $BaO.5TeO_2$ had a linear thermal expansion coefficient of $19 \times 10^{-6}$ and a deformation temperature of 325° C., values radically different from those normally associated with oxide glasses. The refractive index of a prism was 2·08 (for a wave-length of 5780 A.) and the dielectric constant at 50 c./sec. was about 25. A glass having the molecular formula $PbO.5TeO_2$ had a slightly lower expansion coefficient ($17·7 \times 10^{-6}$) and a deformation temperature of about 280° C.; the refractive index at 5780 A. was as high as 2·25.

Many glasses have been prepared with three components, one of them being $TeO_2$ and the second usually PbO or BaO; for example, we have made glasses in the systems $TeO_2$—PbO—$Li_2O$ or $Na_2O$, BaO, $B_2O_3$, $P_2O_5$, $GeO_2$, $V_2O_5$, $Cb_2O_5$, $TiO_2$, $MoO_3$, $WO_3$ and $ZnF_2$. The properties of a few glasses are summarized in Table 1, from which it may be seen that the expansion coefficients are unusually high for oxide glasses, the deformation temperatures are low, and the densities in some cases very high. Of particular interest are the values for the refractive index, which in many cases are higher than for the usual oxide glasses.

Table 1

| Melt No. | 15 | 16 | 2 | 7 | 6 | 8 |
|---|---|---|---|---|---|---|
| Weight per cent $TeO_2$ | 88·2 | 86·4 | 80·4 | 42·5 | 41·1 | 66·3 |
| Weight per cent PbO | 9·8 | 9·6 | 13·5 | 29·6 | 19·1 | 23·2 |
| Weight per cent third component | 2·0 $Li_2O$ | 4·0 $Na_2O$ | 6·1 BaO | 27·9 $B_2O_3$ | 39·8 $WO_3$ | 10·5 $ZnF_2$ |
| Expansion coefficient (50–260° C.) × $10^6$ | 19·7 | 21·5 | 17·5 | 10·2 | 12·7 | 17·3 |
| Deformation temperature (° C.) | 270 | 275 | 305 | 405 | 400 | 280 |
| Density (gm./c.c.) | 5·56 | 5·46 | 5·93 | 4·41 | 6·76 | 6·08 |
| Refractive index for 5780 A. | 2·14 | — | 2·17 | 1·82 | 2·21 | 2·10 |

Of even greater interest are the infra-red transmissions and dielectric properties of the tellurite glasses. Many glasses have now been prepared with dielectric constant in the range 25–30, which is about double the value obtained for any previous oxide glass. As an example, we may quote the values obtained for glass No. 2 over the range of frequency from 50 c./sec. to 1·2 Mc./sec.; the values for dielectric constant and loss angle (as kindly determined for us by Prof. Willis Jackson) are shown in Table 2.

Table 2

| Frequency | $k$ | tan $\delta$ |
|---|---|---|
| 50 c./sec. | *c.* 27·5 | 0·0035 |
| 500 c./sec. | 27·3 | 0·0029 |
| 1,000 c./sec. | 27·2 | 0·0031 |
| 1·2 Mc./sec. | 27·7 | 0·0024 |

It may be noted that the values of $k$ and tan $\delta$ change very little over the frequency-range studied; but no conclusions can yet be made about the exact nature of the small changes with frequency until more accurately ground and polished samples have been prepared for test.

Examination of the infra-red transmission properties of the glasses is under active investigation; at present, it can be said that glasses have been prepared with very low absorption at any wave-length up to at least 5·5 microns. Thus glass No. 8 in Table 1 had a transmission of not less than 70 per cent through a thickness of 1 mm. at any wavelength in the infra-red up to 5 μ, in spite of the fact that there is a loss by reflexion from the two surfaces of 20 per cent because of the high refractive index of the glass.

The properties of many tellurite glasses are under investigation; and we hope to present further results in later communications; in addition to the properties mentioned above, we are also investigating the optical dispersions and the electrical resistivities of tellurite glasses. I am grateful to Mr. L. J. Davies, director of research, for permission to publish this communication.

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## Detection of Diatomic Radical Absorption Spectra during Combustion

The spectra of the CH, $C_2$ and CN radicals which, with OH and NH, form the main part of the emission from hydrocarbon flames and explosions, have hitherto eluded attempts at detection in combustion processes by means of their absorption spectra. This has usually been interpreted as meaning that they are present at very low concentration. We have previously described how the method of flash photolysis and spectroscopy[1] may be used for the homogeneous initiation of explosions, the study of the OH radical in the hydrogen/oxygen reaction[2] and the detection of the CN and NH radicals in absorption during ethylene/nitrogen dioxide explosions[3]. The very short life-time of the latter two radicals made it impossible to study their occurrence in detail, and to this end a modified apparatus has been constructed by which shorter times may be investigated. By this means it has been possible to follow the absorption spectra at intervals of 20 microsec. during the explosion from 30 microsec. after the beginning of the initiating flash.

We have studied acetylene oxygen explosions at about 20 mm. pressure, photosensitized by 1·5 mm. of nitrogen dioxide, and, in addition to obtaining the absorption spectra of CN and NH more strongly, the Mulliken and Swan bands of $C_2$ have been observed very clearly, as well as all the three known systems of CH. The Mulliken bands of $C_2$, which arise from the $^1\Sigma_g$ lower state, appear at comparable intensity with the Swan bands, which arise from the $^3\Pi_u$ state, and this raises the question as to which is the ground-level. The temperature in our system is of the order of 3,000° K., and therefore a separation between the $^1\Sigma_g$ and $^3\Pi_u$ states of 5,600 cm.$^{-1}$, as predicted by Herzberg and Sutton[4], is quite possible; but we hope that an investigation of the dependence on temperature of the relative intensities will settle this point. There has also been some discussion

about the ground-state of the CH molecule[5]; the appearance in absorption of all those systems having the $^2\Pi$ lower state suggests that the $^2\Pi$ is the ground-state or lies closely above it. Two of these systems have been observed in stellar spectra; the system at 3143 A., which has not previously appeared in absorption, is actually the most intense. Finally, in very rich mixtures, there appears a band at 4051 A., which is probably identical with the emission system known as the 4050 group originally attributed to $CH_2$. It occurs only in the region of strong carbon deposition, which lends support to the recent assignment to the $C_3$ molecule[6].

It is found that a complete change in the nature of the spectrum occurs in the region of equimolecular proportions of oxygen and acetylene. On the oxygen-rich side, only the spectrum of OH appears strongly, although CN is observed weakly during the initial rise in OH concentration, which lasts about 300 microsec. On the acetylene-rich side, the $C_2$, CH and CN radicals appear strongly and OH is just visible, whereas the NH radical is observed only when the mixture ratio is very near equimolecular. This has probably been a major factor in the failure to detect these radicals in absorption in flames, as the fuel-rich mixture gives carbon decomposition and luminous flames which cannot easily be investigated. Our spectra indicate a transient concentration of these intermediates which is greatly in excess of the equilibrium one.

The possibility of following the concentration of all the diatomic radicals throughout the course of hydrocarbon combustion is one which can scarcely fail to yield valuable information about the physical and chemical processes involved.

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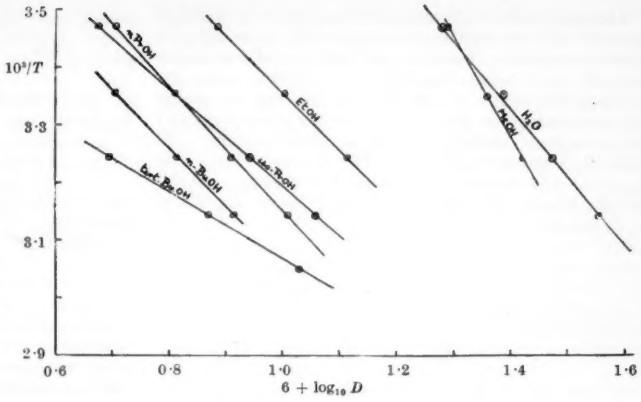


## Self-diffusion of Aliphatic Alcohols

Self-diffusion coefficients for water and a number of alcohols have been measured at a series of temperatures, and experimental activation energies obtained. The hydrogen atom in the hydroxyl group of each alcohol was exchanged with deuterium, and the analyses performed by combustion to water followed by density determinations using a micro-float apparatus[1]. Sintered-glass diaphragm diffusion cells, stirred magnetically[2], were used for the rate measurements. An internal agreement of the order of 0·3 per cent, with an overall accuracy in the diffusion coefficient $D$ of about 0·5 per cent, was achieved. In the case of methyl alcohol, the diffusion coefficient was determined by an alternative procedure using carbon-14, and approximate agreement between the two methods was obtained.

The accompanying graph shows the plot of $\log_{10}D$ against $1/T$, from which the experimental activation energies $E_D$ were obtained. A summary of the experimental results is given in Table 1.

Table 1

| | $D \times 10^5$ cm.²/sec. | | | | |
|---|---|---|---|---|---|
| | 15° C. | 25° C. | 35° C. | 45° C. | 55° C. |
| Water | 1·90 | 2·43 | 2·98 | 3·60 | — |
| Methyl alcohol | 1·93 | 2·27 | 2·65 | — | — |
| Ethyl ,, | 0·768 | 1·01 | 1·30 | — | — |
| *n*-Propyl ,, | 0·504 | 0·646 | 0·814 | 1·017 | — |
| *iso*-Propyl ,, | 0·474 | 0·649 | 0·867 | 1·145 | — |
| *n*-Butyl ,, | — | 0·504 | 0·649 | 0·822 | — |
| *t*-Butyl ,, | — | — | 0·497 | 0·744 | 1·070 |

The available energy and entropy changes for activation, $\Delta G^*$ and $\Delta S^*$, calculated for 35° C. from the general equation of the absolute rate theory[3], are given in Table 2.

$$D = \lambda^2(kT/h) \cdot \exp(-\Delta G^*/RT) \equiv \lambda^2 \cdot (kT/h) \cdot \exp(-\Delta E^*/RT) \cdot \exp(-\Delta S^*/R).$$

As the volume change in diffusion is negligible, $\Delta H^*$ is assumed to be equal to $\Delta E^*$.

The value of $\lambda$, the distance between successive equilibrium positions, was for simplicity equated to $(V/N)^{1/3}$, where $V$ is the molar volume and $N$ the Avogadro number.

Table 2

| | $\Delta G^*$ (kgm. cal./mol.) | $E_D$ (kgm. cal./mol.) | $E_\eta$ (kgm. cal./mol.) | $\Delta S^*$ (E.U.) |
|---|---|---|---|---|
| Water | 3·26 | 3·93 | 3·80 | 0·20 |
| Methyl alcohol | 3·66 | 2·77 | 2·33 | −4·87 |
| Ethyl ,, | 4·25 | 4·62 | 3·30 | −0·78 |
| *n*-Propyl ,, | 4·63 | 4·25 | 4·31 | −3·21 |
| *iso*-Propyl ,, | 4·60 | 5·30 | 5·19 | 0·29 |
| *n*-Butyl ,, | 4·85 | 4·60 | 4·57 | −2·79 |
| *t*-Butyl ,, | 5·03 | 7·50 | 8·20 | 6·04 |

The experimental energies $E_D$ and $E_\eta$ were obtained from the Arrhenius equations, $D = A \exp(-E_D/RT)$ and $\eta = A' \cdot \exp(E_\eta/RT)$, for diffusion and viscosity respectively. These values are related to $\Delta E^*$ as follows: $E_D = \Delta E^* + RT$.

The most striking feature of the results in Table 2 is the small, but regular, increase in $\Delta G^*$, although the individual values of energy and entropy of activation vary in an irregular manner. In the two cases examined, the values of $\Delta G^*$ for the isomers are nearly equal, although in the case of the butyl alcohols the experimental activation energies differ widely. In each case the difference in $\Delta S^*$ for the isomers is equal to the difference in absolute entropy of the liquids (Table 3); the value for *t*-butyl alcohol is extrapolated.

Table 3

| | $\Delta S^*$ | $S^\circ_{298}$ [4] | $\Delta S^* + S^\circ_{298}$ |
|---|---|---|---|
| *n*-Propyl alcohol | −3·12 | 46·1 | 43·0 |
| *iso*-Propyl ,, | 0·37 | 43·0 | 43·4 |
| *n*-Butyl ,, | −2·72 | 54·5 | 51·8 |
| *t*-Butyl ,, | 6·07 | 45·3 | 51·4 |

Further, it is observed from Table 2 that in most cases $\Delta S^*$ increases in a regular manner with $E_D$. A quantitative value of $\Delta S^*$ is difficult to obtain owing to the uncertainty in the value of $\lambda$ in the theory used. If $\lambda$ is assumed to be the smallest dimension of the diffusing molecule[3], the entropy of activation is found on plotting to be almost a linear function of activation energy, the points lying very close to a straight line with no tendency to deviate regularly from it.

Eyring *et al.*[3] assumed the process of diffusion to involve a change in translational energy in a single degree of freedom, the distribution in the other degrees remaining unchanged. The above relationship suggests that the passage of a molecule over the potential energy barrier is assisted by a redistribution of energy which is more complete the greater the height of the barrier. Empirical relations of this kind are already known to hold for some reactions in solution which involve pseudo-ionic or free radical mechanisms[5].

We wish to acknowledge the financial assistance received from the Central Research Fund of the University of London, and hope to report this work in greater detail elsewhere.

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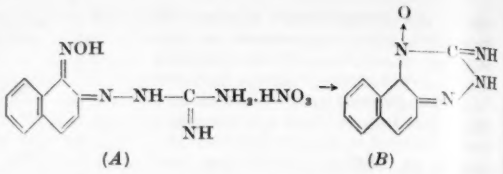
## Oxy-Triazines from Aminoguanidine

Thiele and Dralle[1] reported the condensation of aminoguanidine nitrate and α-nitroso-β-naphthol with the formation of α-oximino-β-naphthylidene-aminoguanidine nitrate. They observed that the initial reaction product (*A*) underwent further change to a material of formula $C_{11}H_8N_4O$ (*B*) on treatment with boiling water, with loss of ammonium nitrate. They gave no structure for (*B*).

The present investigation suggests that (*B*) is an oxy-imino-triazine, the first of its type to be prepared,



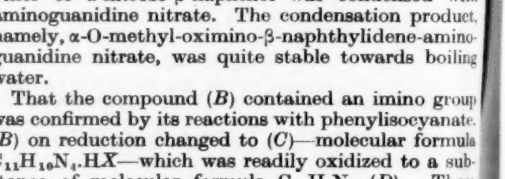

(*A*) (*B*)

and that the latter condensation is an intramolecular process.

Substance (*B*) was found to be amphoteric in nature. It formed salts with sodium, potassium, lithium and with mercuric and silver ions. Similarly, it forms a picrate, picrolonate, flavianate, chloroaurate and chloroplatinate. Both the acidic and basic properties are exceptionally weak. The hydrohalide salts of general formula $C_{11}H_8N_4OHX$ resemble the oxonium salts of the flavones. This instability of the salts of (*B*) indicates the absence of the strongly basic guanidine group. Confirmation of this was found by the Lang reaction[2], standards of arginine hydrochloride and creatine being used to compare the colours developed. Other standard tests[3,4] gave similar results. The absence of primary amino functions in the molecule was indicated in the usual manner[4]. Again, with bromine and alkali no reaction ensues; with bromine itself, however, it forms a tribromo derivative of formula $C_{11}H_5N_4Br_3O$, which is not a perhalide. (*B*) also exhibited no carbonyl activity towards either nitro-aminoguanidine or 2,4-dinitrophenylhydrazine.

Substance (*B*) was unaltered by both dimethyl sulphate and benzoyl chloride in the presence of alkali. It was, however, acetylated by refluxing with acetic anhydride in dry pyridine for 90 min., 54 per cent acetylation taking place[5]. This relative stability towards acyl halides and the reaction of the compound with hydrochloric acid revealed the absence of the oximino group. Thus, in the change of (*A*) to (*B*), both the oximino radical and the guanyl group were involved. The only process which offers a formula for (*B*) consistent with its reactions is that obtained by the formulation detailed above. This involves the reaction of (*A*) in the 'nitrone' form, an assumption analogous to that adopted in the synthesis of oxy-osotriazoles[6]. To confirm this, the O-methyl ether of α-nitroso-β-naphthol was condensed with aminoguanidine nitrate. The condensation product, namely, α-O-methyl-oximino-β-naphthylidene-aminoguanidine nitrate, was quite stable towards boiling water.

That the compound (*B*) contained an imino group was confirmed by its reactions with phenylisocyanate. (*B*) on reduction changed to (*C*)—molecular formula $C_{11}H_{10}N_4.HX$—which was readily oxidized to a substance of molecular formula $C_{11}H_8N_4$ (*D*). These changes may be written as follows:




(*C*) (*D*)

This formula for (*D*), which is that of a naphth-imino-triazine, was confirmed by independent synthesis. Thiele[1] reported the melting point of (*D*) as being 201° C.; De[7] reported the melting point of the above naphth-imino-triazine as being 240° C.

Later work, however, in this laboratory[8] has shown that the triazine obtained by De's method, which has the structure given to (*D*) above, has a melting point of 200°–201° C.

We have extended the above observation to quinone-monoximes, *o*-nitrosophenols and 1,2-mono-oximino-dicarbonyl compounds. The preparation of the oxy-triazines, and the oxyoso- and the oso-triazoles from these materials, is being undertaken.

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## Symmetrical Bi-Aromatics

Previously reported work[1] from this laboratory indicated the feasibility of condensing 2-halo-3-thenoic acids to form symmetrically substituted 2,2′-bithienyls. This provided the experimental basis for the continuation of our studies in the field of mixed bi-aromatics, wherein it was shown[2] that an unsymmetrically substituted α-phenylthiophene actually exists in two stereoisomeric forms due to restricted rotation. In view of this fact, the above method was applied to 3-halo-*o*-substituted thenoic acids in order to study the possible existence of optical activity in the corresponding β-phenyl-thiophenes. Accordingly, the synthesis of a symmetrically substituted 3,3′-bithienyl was undertaken.

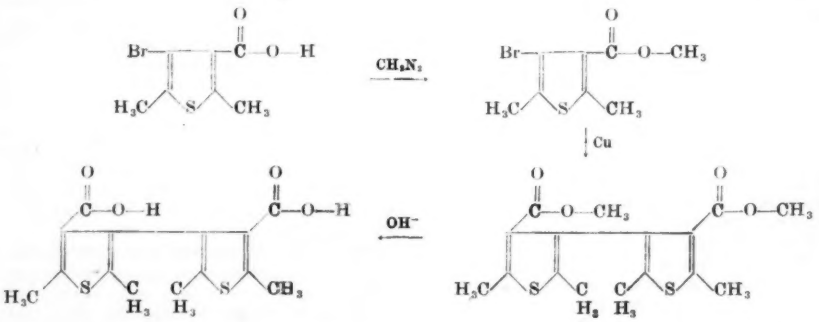
Although some investigations have already been reported in this field[3,4], no work has been published concerning symmetrical 3,3′-dithienyl-dicarboxylic acids.

The readily available 2,5-dimethyl-4-bromo-3-thenoic acid[5] was selected as the starting material in the series of reactions indicated above.

The 2,5-dimethyl-4-bromo-3-thenoic acid was dissolved in methyl alcohol and esterified with diazomethane *via* nitrosomethylurea. After removal of the solvent, the residue was taken up in ether and washed with 10 per cent sodium carbonate solution to remove unchanged acid. The ether layer was then washed with water and dried over anhydrous potassium carbonate. After filtering and removal of the solvent, the residual liquid was fractionally distilled to yield methyl 2,5-dimethyl-4-bromo-3-thenoate (b.p. 138–139°/8 mm.; $n_D^{28°} - 1{\cdot}5591$; calc. for $C_8H_9O_2SBr$: C, 38·55; H, 3·61; found: C, 38·83; H, 3·67 per cent).

This mono-ester was then condensed in the manner of the Ullmann reaction[6], using an excess of Baker's precipitated copper as the condensing reagent. While keeping the temperature of the reaction mixture at 250–255°, the copper was added in small portions during the course of one hour; after the final addition, the temperature was raised to 280° for 15 min. Upon cooling, the mixture was extracted with ether and filtered. The ether and unchanged mono-ester were removed by distillation *in vacuo*, the residual material taken up in ethyl alcohol in the presence of 'Norit-*a*', and allowed to crystallize. The product consisted of yellow plates (m.p. 48–48·5°) and proved to be the dimethyl ester of 2,5,2′,5′-tetramethyl-3,3′-dithienyl-4,4′-dicarboxylic acid (calc. for $C_{16}H_{18}O_4S_2$: C, 56·76; H, 5·33; found: C, 57·05; H, 5·29 per cent).

The corresponding dibasic acid was obtained by refluxing the above di-ester with an excess of 10 per cent aqueous potassium hydroxide. Acidification yielded the 2,5,2′,5′-tetra-methyl-3,3′-dithienyl-4,4′-dicarboxylic acid, which, after sublimation *in vacuo*, gave white crystals melting with decomposition at 295–305° (calc. for $C_{14}H_{14}O_4S_2$: C, 54·19; H, 4·52; found: C, 54·45; H, 4·54 per cent).




This investigation is being carried out under the auspices of the Office of Naval Research.

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## Paper Partition Chromatography of Sulphonamides

The recent communications on paper partition chromatography of sulphonamides by R. Robinson[1] and A. E. Steel[2] prompt us to direct attention to earlier reports by W. H. Longenecker[3] and especially by G. Thomas *et al.*[4]. Isolated examples of the use of this method in the analysis of sulphonamides can also be found in the work of B. Ekman[5] and H. G. Bray *et al.*[6].

We have used several solvent systems, including the butanol–ammonia mixture proposed by R. G. Shepherd[3]. Our results agree with those reported by R. Robinson[1], although the movement of sulphacetamide was found to be much slower.

For the detection of the sulphonamide spots by the diazo and coupling reaction, we found diazotization by gaseous nitrogen oxides very useful. The strips were hung for 30 sec. in a glass vessel at the bottom of which a few millilitres of diluted sulphuric acid had been added to sodium nitrite.

The detection of sulphonamides lacking an unsubstituted aromatic amino group offers difficulty, as almost every colour reaction of the sulphonamides is due to the presence of this group. Succinylsulphathiazole, phthalylsulphathiazole and phthalylsulphacetamide could be detected, however, by the use of an indicator spray, because they are carboxylic acids.

For quantitative measurements we prefer the use of Ehrlich's reagent. After detection by spraying with a 1 per cent solution of *p*-dimethylamino benzaldehyde in diluted hydrochloric acid, the spots were separately eluted with an acid-buffered solution of the same reagent for determination of the sulphonamide content by a modification of the procedure of C. J. O. Morris[7].

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## Inhibitory Effect of Tetraethylammonium-bromide in Alloxan Diabetes

The mechanism of the effect of alloxan has been examined thoroughly by several investigators. For example, Abderhalden[1] found that if the application of alloxan was preceded by an injection of cysteine, he was able to prevent diabetes. Brückmann and Wertheimer found that the level of reduced glutathione in the blood fell after an injection of alloxan. In our previous work[2], we showed that alloxan reacts with SH-groups of blood proteins; this was proved polarographically. Further, we found that we could trace the fall of reduced glutathione not only in the blood but also, after a longer period of time following the injection of alloxan, in the pancreas, liver and, mainly, in the adrenals[4].

Jimenez-Diaz, Grande-Covian and De Oya[5] demonstrated for the first time that tying up the renal hilus prevents alloxan diabetes. Houssay[6] states that alloxan diabetes should not be regarded as concerned entirely with the kidneys, as would seem from previous work; for example, a bilateral nephrectomy causes alloxan diabetes. Houssay and Martinez[7] analysed thoroughly these findings and found that it was sufficient to block the nerve ductus in the renal hilus to prevent diabetes. Houssay *et al.* explained these phenomena with reference to the motor-vascular system of the pancreas. These views have been criticized; for example, A. Gold[8] found no significant differences in rats the kidneys of which were tied up before injecting alloxan, when compared with normal rats; J. L. Duff, D. C. Wilson and G. C. McMillan[9] also did not succeed in reproducing these results with rabbits.

We have therefore endeavoured to find out whether, after tying up the renal hilus, the typical changes in glutathione metabolism would occur following an injection of alloxan. A group of rats starved for 24 hr. was anæsthetized with ether. By the lumbral route both kidneys were uncovered and the renal hilus was tied up. Five hours later, alloxan was injected subcutaneously into the rats in doses of 15 mgm./100 gm. body-weight. The rats were killed with blows on the head after the following intervals: 15 min., 45 min., 90 min., 300 min. We used anhydrous alloxan (Roche, Basle). The livers and pancreas were analysed by the modified Kühnau method to determine reduced glutathione; compared with a group of animals the kidneys of which were not tied up, the level of reduced glutathione had not fallen as it does typically in normal animals injected with alloxan.

With another group of animals we blocked the sympathetic ganglions with tetraethylammoniumbromide, which was injected subcutaneously in doses of 3 mgm./1 kgm. body weight. It proved later that these doses were quite sufficient for our purposes. Five minutes after the injection of tetraethylammoniumbromide, we injected alloxan subcutaneously into the animals in the same doses as in the previous experiments. The rats were killed at definite intervals, and the reduced glutathione in their livers, pancreas and adrenals determined quantitatively. It was found that after tetraethylammoniumbromide injections, there was no fall in the level of reduced glutathione following the injection of alloxan.

This experiment was repeated, except that after the injection of alloxan the rats were put into metabolism cages, where they were given water and food *ad libitum*. Then we used the Cole method for determining glucose in urine to detect glycosuria. After a few days the rats were killed and their blood glucose determined by the Hagedorn–Jensen method.

This experiment was carried out with five subgroups of eight rats each. Tetraethylammoniumbromide was injected in the same doses as in the previous case; the doses of alloxan were also identical. In individual subgroups except group 1, which served as control, we traced the dependence of the origin and character of diabetes upon the length of time which passed between the injection of tetraethylammoniumbromide and the introduction of alloxan:

(*a*) Rats of one subgroup were given alloxan only. They all developed polyuria and glycosuria, and during the experiment they were steadily losing weight. After death the value of blood sugar averaged 212 mgm. per cent.

(*b*) Alloxan was injected simultaneously with the injection of tetraethylammoniumbromide. Glycos-

uria was observed in 70 per cent of animals of this group. Quantitatively, the secretion of sugar was half that in the previous subgroup. No polyuria was observed. The blood sugar averaged 103 mgm. per cent.

(*c*) Alloxan was injected 5 min. after the injection of tetraethylammoniumbromide. Glycosuria was observed in 50 per cent of the experimental animals, while the maximum amount of sugar secreted during 24 hr. did not exceed 0·7 gm. No polyuria. The average blood sugar was 139 mgm. per cent.

(*d*) The rats were injected with alloxan 15 min. after the injection of tetraethylammoniumbromide. Glycosuria was observed in 60 per cent of the experimental animals. (The maximum amount of glucose secreted was 0·7 gm. in 24 hr.) The average blood sugar was 151 mgm. per cent.

(*e*) Alloxan was injected 30 min. after the injection of tetraethylammoniumbromide. Glycosuria developed only in one animal. (The maximum amount of sugar secreted was 0·5 gm. in 24 hr.) No polyuria. The average blood sugar was 149 mgm. per cent.

Our results support the views of Houssay *et al.* and direct attention to the great importance of the nervous system in connexion with alloxan diabetes. Lazarow's ideas[10] of the mechanism of the origin of alloxan diabetes are too simple.

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## Transport of Chloride through the Ruminal Mucosa

It seems obvious that the quantity and composition of the rumen fluid is of importance for microbial activity in the rumen. One of the main factors influencing the ruminal fluid is the properties of the rumen wall.

The rumen fluid is very different from blood plasma in its ionic composition. Phosphate and potassium are far more concentrated in the rumen than in plasma; but the chloride concentration in the rumen of goats, sheep and cows is usually only 0·2–0·1 of the concentration in plasma. This might be due to the low chloride content of the food and especially of the saliva.

However, if sodium chloride is introduced into the rumen, the elevated chloride level rapidly returns towards the initial level. Similarly, bromide and iodide introduced into the rumen seems to disappear rapidly and almost completely. These facts suggest that an active transport through the ruminal wall occurs. Such experiments are, however, difficult to interpret.

To investigate this matter more conclusively, rumen pouches have been made in a few young goats. The posterior ventral blind sac of the rumen has been separated. Care has been taken not to interfere with the blood supply.

The changes occurring in ruminal fluid and in salt solutions introduced into the rumen pouch have been studied. The results of an experiment with salt solutions are shown in the accompanying table.

| Time | | Concentrations (millimoles/litre) | | | |
|---|---|---|---|---|---|
| | | $Na^+$ | $K^+$ | $HPO_4^{--}$ | $Cl^-$ |
| 0 | 150 ml. introduced | 160 | — | 31 | 86 |
| 4·5 hr. | 39 ml. removed | 156 | traces | 36 | 77 |
| 22 hr. | Pouch emptied, 45 ml. | 152 | 27 | 70 | 28 |
| Total introduced (millimoles) | | 24 | 0 | 4·65 | 12·9 |
| Total removed (millimoles) | | 12·9 | 1·2 | 4·55 | 4·3 |

The experiments leave scarcely any doubt that chloride passes from the rumen as a result of active processes in the rumen wall. It seems probable that the same is true for sodium ions. Potassium ions, on the other hand, may pass in the opposite direction, and against the concentration gradient. Phosphate ions do not appear to pass through the epithelium in significant amounts in these experiments. Tracer experiments suggest, however, that phosphate may pass through the ruminal epithelium, though very much more slowly than chloride.

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## Urinary Porphyrins in Experimental Lead Poisoning

The porphyrin excreted in the urine of normal and of experimentally lead-poisoned rabbits has long been regarded as coproporphyrin. The recent development[1] of a chromatographic method for the separation of porphyrins according to the number of carboxyl functions has already revealed 3- and 5-carboxyl porphyrins in a number of pathological urines. We have investigated the urinary ether-soluble porphyrins of rabbits which received loading doses of 13·7 mgm./kgm. of lead chloride intravenously, and were then fed on a diet containing 250 p.p.m. of lead carbonate for periods up to four months. Urine was collected over periods of three days and preserved with toluene. The porphyrins were extracted with ether and acetic acid by the technique previously used by one of us[2], and estimated in 0·25 per cent hydrochloric acid with a Unicam spectrophotometer ($\lambda = 401$ mμ). They were chromatographed on paper at 7° C. by the method of Nicholas and Rimington[1] to characterize the porphyrins present.

The apparent porphyrin content of these urines increased with standing, as did that of the initial ether extracts (cf. Eriksen[3]). Addition of a trace of iodine to the ether extracts did not accelerate the appearance of red fluorescence in them or in 5 per cent hydrochloric acid shaken with them, in contrast to the behaviour of the precursor described by Watson *et al.*[4]. Quantitative estimates

were made on samples collected over a standard period and extracted under approximately standard conditions; and as re-extractions of the original urine or its first ether extract after further standing revealed little or no additional porphyrin, the error due to unconverted porphyrin was not large. However, the proportion of the estimated material which was excreted as precursor is not known, and immediate examination of catheter specimens of urine has suggested that it is probably large. The coproporphyrin excretion of normal rabbits so estimated was equivalent to $4{\cdot}8 \pm 2{\cdot}1$ (s.d.) μgm. per kgm. body-weight per day: after administering lead chloride as described above, it rose at once to $79{\cdot}5 \pm 4{\cdot}4$ (s.d.) μgm./kgm. per day and then declined gradually, so that it was still slightly above normal four months after the initial dose of lead.

On the paper chromatograms, the bulk of the porphyrin, both from normal controls and lead-poisoned animals, ran with an $R_F$ corresponding to the presence of material with four carboxyl groups, identical with that of the pure coproporphyrin marker. Porphyrins with $R_F$ corresponding to three and to five carboxyl groups were also observed in all but the smallest specimens. Lead poisoning did not appear to alter the relative proportions of these three porphyrins, though the 3- and 5-carboxyl porphyrins are easier to detect in lead poisoning because of the high total yield. Several porphyrin fractions, probably differing in the proportions of 3-, 4- and 5-carboxyl porphyrins present, were prepared by aluminium oxide column chromatography, as described by Nicholas[5], from the urines of animals which had received lead. Chromatographic and chemical details of these fractions will be reported separately.

Four lead-poisoned rabbits were treated with folic acid (5 mgm./kgm.), pyridoxine (5 mgm./kgm.), cyanocobalamin (vitamin $B_{12}$, 5 mgm./kgm.), or 0·9 per cent sodium chloride (0·5 ml./kgm.) given intramuscularly twice daily for three days, the treatment being repeated at five weekly intervals on a Latin square arrangement until each animal had received each treatment. Porphyrin excretion determined during the three-day periods before, during and after treatment was not significantly altered by any of these treatments, and no treatment had a consistent effect in all four rabbits.

We find no evidence that chronic lead poisoning affects the balance between the urinary 3-, 4- and 5-carboxyl porphyrins compared with the normal rabbit. If the porphyria were due to a blockage of normal decarboxylation, some such shift might be expected to occur. Much of the porphyrin is excreted in the form of non-fluorescent precursor. We have failed to affect the porphyria qualitatively or quantitatively by the administration of the vitamins named.

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## Chromatophorotropic Effect of Adrenocorticotrophic Hormone

Continued absence of a hormone in the body induces overproduction of the corresponding pituitary 'tropin'. This rule has been proved and applied diagnostically by demonstrating tropins in the urine of patients suffering from hypogonadism or hypothyroidism. It seems to hold true also for chronic adrenal cortex insufficiency.

There are three reasons why in the Addisonian patient chronic over-production of adrenocorticotrophic hormone may be responsible for skin pigmentation: (*a*) pigmentation develops especially in chronic cases, whereas it is absent in acute cases; (*b*) corticoid treatment may abolish all clinical manifestations of insufficiency, but has slow effect on the pigmentation; (*c*) adrenocorticotrophic hormone treatment or over-production (pituitarian Cushing syndrome) produces pigmentation.

In view of these considerations we decided to study the chromatophorotropic effect of adrenocorticotrophic hormone ('intermedin-like effect') on frogs.

*Technique.* The tree frog (*Hyla arborea*), weighing 5–10 gm., proved to be a suitable test animal. When kept for several weeks in captivity, it assumes a uniform, bright-green colour, which does not change spontaneously or after injection of unspecific extracts. The frogs are tested before use by subcutaneous injection of 0·1 mgm. of *l*-cystine and are kept on a brown table. Only animals remaining green are used. This technique makes unnecessary the use of hypophysectomized frogs.

The melanophoric effect was classified as indicated in Table 1. The criterion applied was a change of colour of the whole dorsal skin. Injection of pituitary extracts produced all the successive colours of the scale within a short time. Amino-acids, especially *l*-cystine, gave a reaction only in recently captured frogs, and the colour changes were much slower.

Table 1. Classification of Chromatophorotropic Effect in *Hyla arborea*

| Colour | Designation | Appearance of darkening after injection of | |
|---|---|---|---|
| | | Pituitary hormones | Amino-acids† |
| Bright green | — | — | — |
| Dark green | ± | 7–10 min. | 10–15 min. |
| Olive green | + | 20–30 min. | 1–5 hr. |
| Beige brown | ++ | varying* | 5–10 hr. |
| Dark brown | +++ | 2–4 hr. | 5–10 hr. |

* This stage does not occur in most cases.
† This reaction occurs only in frogs not yet fixed to the bright green colour, which is the prerequisite for the testing of pituitary hormones.

*Results.* Our results with various pituitary hormones are shown in Table 2. Adrenocorticotrophic hormone was active down to 0·01 gamma. The quantitative differences between various commercial preparations corresponded roughly to their declared values in international units. Pitressin gave a positive reaction only at a dosage of 10 gamma, and pitocin did not produce a positive response up to 5 I.U. (higher doses were lethal). Some of the tropins of the anterior pituitary lobe gave positive reactions in very large doses. None of the peripheral hormones tested was positive (œstrogens, androgens, progesterone, corticoids, thyroxin, insulin, adrenalin, parathormone, etc.). We tested thirty-five amino-acids and biogenic amines as well as glycyrrhiza with negative results. Injections of phosphate buffer, *p*H 5–10, were likewise negative.

Table 2. MINIMAL CHROMATOPHOROTROPIC DOSE OF VARIOUS PITUITARY HORMONES IN *Hyla arborea*

| Hormones* | Preparation | Minimal effective dose after subcutaneous injection (gamma) |
|---|---|---|
| ACTH | Armour Lot 84-5 *HSI*<br>Organon (Holland) Batch 5 cortrophine<br>Armour *ACTHAR*<br>International Standard | 0·01<br>0·01<br>0·1<br>1 |
| Pitressin | Parke-Davis and Co. 0·5 I.U.<br>Richter (Hungary) Tonitrin 0·5 I.U.<br>Lilly (Post. Pit. Pwd.) 0·1 I.U. | 10<br>10<br>100 |
| Pitocin | Parke-Davis and Co. 5 I.U.<br>Bayer (Orasthin) 5 I.U. | —<br>— |
| Thyrotropin | Armour Lot 129/31<br>Organon (Ambinon) 0·5 c.c. = 50 U. | 100<br>— |
| Prolactin | Squibb and Sons (Luteotrophin) 10 I.U.<br>International Standard 1 I.U.<br>Glaxo 200 I.U. (20 mgm.)<br>Armour Lot B–P 300–130 A. 3 mgm. | 10,000<br>100<br>—<br>— |
| Somatropin | Parke-Davis and Co. (Antuitrin *G*) 6 U. | — |
| Gonadotropin | Searle (Gonadophysin, Pit. *G*) 1 R.U.<br>Squibb and Sons (Pit. *G.*) 100 R.U.<br>Armour (Pit. *G.*) Lot 212–108; 2·5 mgm.<br>Ayerst, McKenna and Harrison *PMBG* (Equinex) 4,000 I.U.<br>Organon (Holland) *Ch.G.* (Pregnyl) 1,000 I.U. | 100<br>—<br>—<br>—<br>— |

*We acknowledge the generous help of many manufacturers, including those mentioned.

*Discussion.* The melanophorotropic effect with such minute doses of adrenocorticotrophic hormone is strong support for our assumption that it is identical with intermedin (Zondek). It could be argued that adrenocorticotrophic hormone is highly contaminated with intermedin. This is, however, improbable, since the effective dose for adrenocorticotrophic hormone, 0·01 gamma, is of the same magnitude as the dose given for intermedin in the literature. On the other hand, it should be borne in mind that it is customary to ascribe the chromatophorotropic effect of posterior lobe extracts to contamination (for example, by diffusion of intermediate lobe hormone). This is also indicated by our results. Our experiments thus support the conclusion that adrenocorticotrophic hormone is the chromatophorotropic hormone. Further studies are in progress to test this contention.

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Oct. 17.

## Oil-bearing Seeds of Possible Economic Importance to West Africa

THE seeds which form the subject of this communication are obtained from *Herrania* spp. (Sterculiaceæ), which are indigenous to the Amazon valley. They were included in a collection of *Theobroma* spp. received from Trinidad in 1944, when they were planted in Accra Quarantine Station; the seedlings were planted in the field at Tafo in June 1945. These *Herrania* spp. have been provisionally classified as *H. balaënsis* Preuss, *H. mariæ* sp. "A" and *Herrania* sp. "B".

The deeply grooved pods are borne only on the trunk and vary in length from 3 in. to 5 in., *H. mariæ* being invariably the longer. They contain approximately twenty-five seeds which are very small and light, the fresh contents of four pods weighing about one ounce. Trees produce two crops per annum, are early-bearing and potentially high-yielding. From the small number of stands in bearing, it is not yet possible to assess accurately the yield per acre.

The chemical analyses which follow are typical of samples harvested from January 1950 to July 1951. The seeds were removed from placental tissue and dried at 100° C. for 15 hr. before duplicate estimations were carried out.

TABLE 1
(Percentages are calculated on the weight of oven-dried material)

| Material | % Moisture | % Oil | % Total nitrogen | % Protein nitrogen | % Theobromine (calc. on fat-free material) | % Caffeine (calc. on fat-free material) |
|---|---|---|---|---|---|---|
| *Herrania balaënsis* | 30·8 | 64·4 | 2·65 | 1·95 | 0·13 | 0·69 |
| *Herrania mariæ* (sp. "A") | 29·1 | 64·1 | 2·42 | 1·94 | 0·10 | 0·77 |
| *Herrania* (sp. "B") | 28·6 | 63·3 | 2·40 | 1·90 | 0·13 | 0·63 |

The result of outstanding interest is the high oil content of the seeds; the highest oil value found to date is 66·1 per cent from a sample of *H. balaënsis*; and these or other *Herrania* spp., not at present grown in West Africa, may, under optimum cultural conditions, improve on this figure. It is also of note that the figures and range of variation for total and protein nitrogen and also sucrose (1·30–2·00 per cent) of the above species closely resemble those I obtained[1] for fresh, unfermented, West African Amelonado cacao beans. On the other hand, the percentage of total alkaloids is approximately one-third that of Amelonado beans, and the theobromine – caffeine ratio is reversed. The caffeine values are comparable with the lower limit of the range for coffee beans and kola nuts[2], and on two occasions

Fig. 1. Habit of bearing of *Herrania* spp. × ½

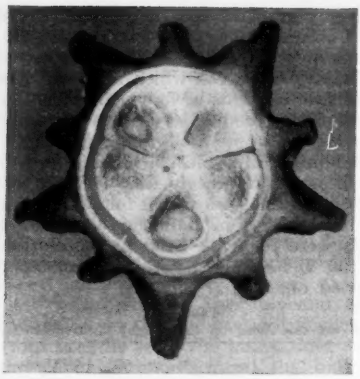

Fig. 2. Cross-section of pod. Full size

values greater than 1 per cent have been obtained. The figure for reducing sugars (0·4 per cent) is four times the amount found in Amelonado beans[1].

The freshly extracted fat from all three species is pale yellow in colour and liquid at room temperatures (25–29° C.), with an odour resembling linseed oil. It has a specific gravity (30° C.) of 0·93–0·94, $n_D^{30}$ = 1·4652–1·4670 ($n_F^{30} - n_C^{30}$ = 0·00762–0·00917), and unsaponifiable matter less than 1 per cent. The chemical constants of most interest are summarized in Table 2.

Table 2

| Material | Sap. value | Iodine value | Thiocyanate value | % Free fatty acids in oil | Composition of the acids (approx.) (ref. 4) |
|---|---|---|---|---|---|
| *H. balaënsis* | 205 | 41–3 (R–K)<br>41–2 (Wijs) | 22–23 | 2·7–2·8 | 22% linoleic acid<br>2 % oleic acid<br>76% saturated acids |
| *H. mariæ* (sp. "A") | 203 | 46–7 (R–K)<br>46–7 (Wijs) | 24–25 | 2·4 | 26% linoleic acid<br>— oleic acid<br>74% saturated acids |
| *Herrania* (sp. "B") | 206 | 39–40 (R–K)<br>39–39·5 (Wijs) | 23·5–24·5 | 2·3–2·4 | 18% linoleic acid<br>7% oleic acid<br>75% saturated acids |

(R–K) = A modification of the Rosenmund–Kuhnhenn method (ref. 3) which gives consistent and reproducible iodine numbers under local conditions.

These seeds are unlikely to be of use in chocolate manufacture, as the freshly extracted fat is liquid at laboratory temperatures; but they may well prove to be a source of edible oil.

I am indebted to Mr. R. J. Benstead, agronomist-in-charge, and to Mr. H. H. Rogers, plant breeder, both of this Institute, for the photographs and for advice on classification respectively. I also wish to thank Prof. J. Graham, University College of the Gold Coast, for the use of a refractometer, and Dr. W. D. Raymond, Colonial Products Advisory Bureau, London, for estimation of the thiocyanogen values and confirmation of the iodine values by Wijs's method, both of which produce variable results under local conditions. Finally, I have to thank the Director of Cacao Research for his interest in this work and for permission to publish this communication.

J. A. R. MacLean

West African Cacao Research Institute,
Tafo, Gold Coast. Nov. 13.

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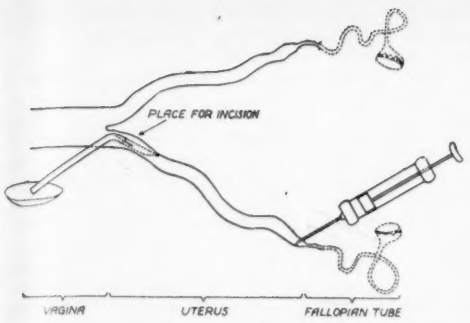
## A Method for Continuous Chromosome Control of Growing Rabbits

In experiments for inducing heteroploidy in the Mammalia, it is of utmost interest to follow the chromosome picture of a treated animal through the developmental period from immediately after fertilization of the egg until adult age has been reached, or at least until sexual maturity. Beatty and Fischberg[1] have described a method for obtaining mouse blastocysts for chromosome counts three and a half days after treatment of tubal eggs with cold- or hot-shock, that is, at the pre-implantation stage when the dividing cells usually contain large chromosomes. In rabbits it is most convenient to work with blastocysts at the age of 5–5½ days after copulation. At this age the diameter of the eggs is about 1–1·5 mm., but large variations are found. In older blastocysts, for example, six days old, it is often difficult to get good squash preparations due to the explosive break-up of the blastocysts, after which the different layers are difficult to spread out; although this can be done after some experience with a pair of needles. In two- to three-day old eggs, the individual cells are a little larger than from the fourth day, but the number of divisions is smaller. (This is a subjective view; no direct measurements of the cell diameter have been made.) The disadvantage in using blastocysts in studies of the chromosome number lies in the fact that it is very difficult to separate the trophoblast cells from the inner layer, and, so far as we know, nothing is known about the difference or variation in chromosome number from these different tissues. This work requires further examination.

It is clear that it is impossible to make chromosome counts throughout the development of a blastocyst. But by washing the eggs out of, for example, the left uterine horn, it is possible to obtain the probable chromosome picture of the litter mates before birth. In our experiments with colchicine treatment of either the does or the fertilized eggs, we have adopted this method in several cases. The technique for washing out the blastocysts from the uterus is as follows. After laparatomy, the uterus is pulled out. A small incision is made at the vaginal end of the uterine horn, and a bent glass tube of approximately 10 cm. length with a lumen of about 3 mm. is inserted about 1 cm. into the horn, and held in position with two fingers. With a syringe, which is inserted into the lumen of the uterus just below the Fallopian tube, 5 c.c. of saline solution is flushed through the horn and collected in a watch glass (cf. diagram). The opening in the uterus is then closed with a catgut suture. If it is preferred to work with younger eggs, the syringe must be inserted into the Fallopian tube either through the fimbrial opening or through the wall. After the washing out, the organs are put back in the abdomen, which is closed with metal sutures. The opening in the abdominal wall is about 3 cm. long (cf. Venge, ref. 2). The same method has been applied for collecting a large number of blastocysts from both uterine horns after hormonal treatment of the does for superovulation. The largest number of blastocysts obtained in this way was from a female Polish, six months old, which delivered thirty-three living blastocysts six days after mating.




In one of our series, twenty-two does were treated in different ways with colchicine, and five–six days after copulation the blastocysts were washed out from the left side of the uterus. In two cases we found only blastocysts, and no young were born later on; in another case we found no blastocysts in the left horn, although the doe gave birth to two young at normal time (from the right horn). Such results are to be expected, considering the normal variation in the number of released ova or the litter size. The number of eggs and young from this series are shown in the accompanying table.

| | Blastocysts | Young | Blastocysts + young |
|---|---|---|---|
| Total number | 66 | 52 | 118 |
| Average per doe | 3·00 | 2·36 | 5·36 |
| Stand. deviation | 1·57 | 1·40 | 1·85 |

Although there is a difference between the number of blastocysts and the number of young at birth in a direction which is to be expected, this cannot be demonstrated as significant ($P > 0{\cdot}1$), and it is concluded that the washing and the surgical procedure has no deleterious effect on the pregnancy.

When a male within a litter is eight–ten weeks old, a unilateral castration is performed. This will not disturb the growth or the breeding value of the male. Testicles from young males offer very suitable material for chromosome studies, as there are plenty of divisions, and it is very easy to make excellent squash preparations. As the males grow older and reach sexual maturity (about six months old) a new chromosome control can be carried out either by castrating the other side, or on the cornea[3]. Testicles from old males are, according to our experience, very troublesome material to work with, and often a large number of preparations must be made before good metaphases are found. If a second castration has been carried out, the corneal tissue can still be used after growth has ceased. The loss of the breeding ability has to be weighed against the better preparations. For females we have tried different tissues, for example, bone marrow, parts of the peritoneum, etc.; but hitherto we have relied upon the cornea.

In addition, it should be mentioned that the best results are obtained by using fresh material. Acetic-alcohol (1 : 3) is used as the fixative according to Melander (personal communication), and not aceto-carmine[4]. After fixation for 15–30 min. the blastocysts are stained in 45 per cent aceto-orcein for one hour at room temperature. Testicles are fixed in the same way and then subjected to the Feulgen method[4] with 6 min. hydrolysis at 60° C. Eyes are stained with orcein. After staining, the corneal epithelium "is scraped from the edge toward the centre of the cornea" as described by Gay and Kaufmann[3]; then we cut the tissue into small pieces with a pair of needles for making the squash.

The results from the colchicine experiments will be published elsewhere.

OLE VENGE

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Uppsala. Nov. 1.

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[3] Gay, H., and Kaufmann, B. P., *Stain Technol.*, **25**, 209 (1950).
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[5] Darlington, C. D., and la Cour, L. F., "The Handling of Chromosomes" (1947).

## Tetraploid Diœcious *Melandrium*

IN 1942 I published a short note[1] on a tetraploid plant of diœcious *Melandrium* found growing wild in Svalöv in southern Sweden. The specimen in question was a female individual growing between the fields behind the place where the new laboratories of chemistry and cytology were erected later. Its flowers were red, as in *M. diœcum* ssp. *rubrum*[2]; the leaves were thick, like those of the coastal ecotype of this subspecies. Morphological comparisons seemed to indicate that this plant was identical with the type described as *M. crassifolium* by Fries[3], especially as regards the size of the cells and thickness of the leaves. It was furthermore said that the closer morphological and microscopical analyses of *M. crassifolium* and *M. rubrum* ssp. *lapponicum* Simmons indicated that those types were identical, thus indirectly stating a rather wide coastal and montane distribution of the tetraploid.

When the results of my cytogenetical studies of some of the differences between the red- and white-flowered races of *Melandrium diœcum* were published[2], no reports were given on the tetraploid type or of the Scandinavian ecotypes of the species. A considerable amount of material had, however, been investigated in order to ascertain if the hypothesis of the distribution of the tetraploid were correct. I myself had collected material in Lapland in 1942 as well as on the coasts of western Sweden, and several Swedish and Norwegian colleagues had collected seeds and living plants for me in the Scandinavian mountains as well as on the Swedish and Norwegian coasts all the way up to Troms. These samples were studied from the cytological and morphological points of view, and all the individuals were found to have the diploid chromosome number $2n = 24$. The thick-leaved plants were found, however, to have bigger cells than the other ecotypes, as observed in 1942[1] and later confirmed by Baker[4] for material from the Scottish isles. Such differences in cell-size of cytologically identical ecotypes had also been observed in *Silene maritima*[5]. My results in *Melandrium* were not worked out further, as I moved to Iceland in 1945 and did not have any facilities for scientific work of this type there.

Baker and Jackson[6] have recently quite correctly called in question the identity of my tetraploid type and *M. crassifolium*. They have studied the chromosome number of thick-leaved plants from the Norwegian mountains and the Alps and found only diploid numbers. Baker[4] also counted $2n = 24$ chromosomes in the coastal ecotype from the north of Great Britain. From their results and mine, it is quite obvious that the tetraploid female plant studied by me in 1942 must have been an aberrant.

The specimen studied by me in 1942 was collected not far from the fields where Dr. E. Åkerlund[7] cultivated a quantity of *Melandrium* some few years earlier. Whether the plant belonged to some foreign and natural line of his material, or whether it was produced by an accidental doubling of its chromosomes, is, and will remain, unknown.

Doris Löve

Department of Botany,
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Winnipeg. Nov. 18.

[1] Löve, D., *Hereditas*, **28**, 241 (1942).
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## A Gene-controlled Flowering Inhibitor in *Pisum*

Von Denffer[1] has recently suggested that the stimulus to flowering is not brought about by the production of a new flowering hormone ('florigen') but results from the sudden drop in production of a flower inhibitor substance ('Blühhemmstoff'). We have been investigating the mode of action of the genes controlling the earliness or lateness of flowering in the garden pea, and have evidence that the late varieties are late because they produce an inhibitor which is absent from the earlies. We have used three varieties: Massey, which normally flowers about the ninth node; Richard Seddon, which flowers at about the fourteenth node; and Telephone, flowering at the seventeenth node. Pellew[2] has suggested that a series of three multiple alleles, $L$, $l_1$ and $l_2$, determine these differences in flowering behaviour, the dominant $L$ gene determining late flowering (eighteenth node). It is probable that our three varieties are respectively $l_2l_2$, $l_1l_1$ and $LL$. However, the genetical tests are not yet complete.

Our technique is as follows. The peas are germinated in damp sand or *Sphagnum* in a heated greenhouse at a temperature of 15–20° C. At about four days old the plumules are approximately one to two centimetres long. At this stage, cleft grafts are easily made between the epicotyls of the stocks and scions of either the same or different varieties. Reciprocal grafts between Telephone and Massey and Telephone and Richard Seddon have been made. The peas are then grown on in pots in a heated greenhouse under natural illumination. The results of a typical experiment using Telephone and Massey are given in the table. The significance of the difference between the means of the various comparisons possible is also indicated ($t$ or normal deviate test). The results show that a scion of a late variety grafted on to an early stock is made significantly earlier over the ungrafted controls, while an early scion grafted on to a late stock flowers later than when ungrafted. Further, grafting itself, in the case of Telephone, causes a significant decrease in node number. Grafting has apparently no effect on the flowering node of the early variety.

These results are best interpreted on the assumption that flowering behaviour in the pea is determined by the production of an inhibitor in late stocks, which is then transported to the plumule. Since grafting alone decreases node number in Telephone, we must also assume that the plumule can react to the inhibitor only over a relatively short time (probably at most two or three weeks) or that the stocks soon stop producing the inhibitor. The temporary interruption of the supply of inhibitor by the mere operation of grafting will thus produce an earlier scion. It is difficult to estimate the length of this interruption, but the scions recover their normal growth-rate three to four days after the operation.

These assumptions were further tested by removing the cotyledons from the seedlings. Under the conditions of our experiment, this operation is fatal if performed earlier than three days after the peas are soaked in water. After this date the excised embryo can survive and flower. The table shows that removal of the cotyledons has no significant effect on Massey, but produces a significant effect on Telephone, making it earlier. Thus the inhibitor is produced in the cotyledons of the late variety.

In these experiments, as the table shows, we have not succeeded in making the complete transformation of the pattern of flowering of any one variety into that of another variety. This may be due simply to the fact that at least a three-day germination period must elapse before the grafting or excision experiments can succeed. It may also mean that the action of these genes starts while the seed is growing in the pod. In either case the speed of action of the genes is remarkable.

With regard to the nature of the inhibitor, it is probably of a hormonal nature. Bonner and Thurlow[3], Thimann and Leopold[4] and von Denffer[1] have shown that physiological concentrations of auxin delay or even suppress flowering in a variety of plants. Experiments to test the effects of auxin on these varieties of peas are in progress. We have, also, some evidence that the rate of respiration during the early stages of growth may differ between late and early varieties, and there may also be a difference in the vitamin C and amino-acid contents of the germinating peas.

| Experimental treatment | Treatment No. | Massey on Telephone | | | | | Telephone on Massey | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | No. of plants | Node of 1st flower | Comparison | Difference | $P$ | No. of plants | Node of 1st flower | Comparison | Difference | $P$ |
| Ungrafted control | 1 | 45 | 9·27 | 1–2 | −0·23 | 0·5–0·4 | 63 | 17·59 | 1–2 | −0·51 | 0·02 |
| Grafted control | 2 | 24 | 9·04 | 1–3 | 1·83 | <0·001 | 36 | 17·08 | 1–3 | −2·61 | <0·001 |
| Experimental graft | 3 | 31 | 11·10 | 1–4 | 0·44 | 0·2–0·1 | 63 | 14·98 | 1–4 | −1·53 | <0·001 |
| Cotyledons removed | 4 | 38 | 9·71 | 2–3 | 2·46 | <0·001 | 51 | 16·06 | 2–3 | −2·10 | <0·001 |
| | | | | 2–4 | 0·67 | 0·02–0·01 | | | 2–4 | −1·02 | <0·001 |
| | | | | 3–4 | −1·39 | <0·001 | | | 3–4 | 1·08 | <0·001 |

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Oct. 28.

[1] Denffer, D. v., *Naturwiss.*, **37**, 296 and 317 (1950).
[2] Pellew, C., *J. Genetics*, **39**, 363 (1940).
[3] Bonner, J., and Thurlow, J., *Bot. Gaz.*, **110**, 613 (1949).
[4] Thimann, K. V., and Leopold, A. C., *Amer. J. Bot.*, **36**, 342 (1949).

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

## Monday, April 7

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. K. A. Zandstra: "Wood Glueing in Industry".

## Monday, April 7—Tuesday, April 8

BRITISH ECOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 10.30 a.m. each day.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON AND SOUTH-EASTERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the large Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5 p.m. on Monday, and at 4 p.m. on Tuesday.—Symposium on "Electrolytic Processes in Chemical and Metallurgical Industry".

## Monday, April 7—Wednesday, April 9

INSTITUTION OF ELECTRICAL ENGINEERS, EAST MIDLANDS CENTRE (at Loughborough College, Loughborough).—Convention on "Electrical Contacts".

## Tuesday, April 8

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. B. R. Horsfield and Mr. D. C. Smith: "A.C. Signalling—a Review of Current Problems".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1) at 5.30 p.m.—Messrs. A. G. Monroe, H. A. S. Bristow and J. E. Newell: "Heat Transfer to Boiling Liquids at Low Temperatures and Elevated Pressures".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. G. Jenkins and Mr. A. H. McKeag: "Photo-Luminescence as Applied to Lighting".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, POLAROGRAPHIC DISCUSSION PANEL of the PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Scientific Papers.

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.30 p.m.—Dr. M. O. Pelton: "The Design and Manufacture of Optical Instruments".

## Tuesday, April 8—Thursday, April 10

FARADAY SOCIETY (in the Department of Chemistry, The University, Leeds).—General Discussion on "Radiation Chemistry".

## Wednesday, April 9

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, PHYSICAL MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "Industrial Resettlement" (to be opened by Sir Hugh Griffiths and Dr. A. A. Eagger).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. F. Dorey, F.R.S.: "Some Observations on Corrosion in Engineering".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Symposium of Papers on "Microwave Links".

ROYAL STATISTICAL SOCIETY, STUDY SECTION (at the E.L.M.A. Theatre, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. M. J. Elsas: "The Problem of Estimating Housing Needs".*

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting; Prof. Ancel B. Keys: "Health and the Diet in the Western World".

## Thursday, April 10

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. Emlyn Jones: "Synchronizing and other Problems".

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURERS FOR AGRICULTURAL ENGINEERING, AGRICULTURAL BIOLOGY, AGRICULTURAL CHEMISTRY, AGRICULTURE (extra mural department)—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford (April 12).

PRINCIPAL OF THE KEVIN STREET TECHNICAL INSTITUTE—The Chief Executive Officer, Town Hall, Merrion Road, Ballsbridge, Dublin (April 15).

ASSISTANT mainly for FIELD RESEARCH work on moorlands in the north of England—The Establishment Officer, Nature Conservancy, 91 Victoria Street, London, S.W.1 (April 18).

POWER GENERATION ENGINEER in the Mechanical and Electrical Engineering Branch of Production Department at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/447 (April 19).

PROFESSOR OF MATHEMATICS at the University College of Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 19).

LEVERHULME STUDENTSHIP IN CHEMICAL ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (April 21).

ASSISTANT LECTURER IN SOCIAL AND GENERAL PSYCHOLOGY—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (April 23).

DIVISIONAL ENGINEER (Mechanical) to be responsible for all forms of mechanical engineering, including equipment of large modern sewage works—The Clerk of Council (CL/G), London County Council, County Hall, London, S.E.1 (April 23).

ASSISTANT MASTERS (with a university degree or equivalent qualification) IN MATHEMATICS, PHYSICS OR ENGINEERING (Electrical or Mechanical) in H.M. Dockyard Schools—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4131/52 (April 24).

SUPERVISING PETROLEUM TECHNOLOGIST in the Bureau of Mineral Resources, Geology and Geophysics, Petroleum Technology Section, Melbourne, to supervise mud engineering and subsurface geological operations in test drilling for oil and scout boring for coal—The Deputy High Commissioner, Australia House, Strand, London, W.C.2, endorsed for attention of 'The Senior Representative, Division of Industrial Development' (April 25).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. 3788) to lead a scientific unit that will include a geologist, geomorphologist, pedologist, ecologist and systematic botanist; a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Ecologist) (Ref. 3789) to serve as plant ecologist to the unit; and a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Systematic Botanist) (Ref. 3790) to serve as systematic botanist to the unit; in the Land Research and Regional Survey Section of the Commonwealth Scientific and Industrial Research Organization which is preparing to undertake surveys in Papua and New Guinea—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (April 26).

UNIVERSITY LECTURER IN GENERAL PSYCHOLOGY—The Secretary of Faculties, University Registry, Oxford (April 28).

HEAD OF THE DEPARTMENT OF PLANT PHYSIOLOGY—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (April 30).

PHYSICAL CHEMIST (Research Officer) or ASSISTANT RESEARCH OFFICER IN THE PAINT INDUSTRIES RESEARCH INSTITUTE, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 1).

CHAIR OF BIOCHEMISTRY at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

SENIOR LECTURER IN ANATOMY, a SENIOR LECTURER IN HISTOLOGY, a SENIOR LECTURER IN PHYSIOLOGY, and a SENIOR LECTURER IN BIOCHEMISTRY, at the non-European Medical School (University of Natal), Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 15).

PRINCIPAL OF THE MUNICIPAL COLLEGE OF TECHNOLOGY—The Chief Education Officer, Education Offices, Deansgate, Manchester 3 (May 17).

WALTER MERSH STRONG RESEARCH FELLOWSHIP (University of Sydney) for original research in Papua in any of the biological, physical or social sciences related to Papua or in Papuan History or Linguistics—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 30).

SENIOR LECTURER or LECTURER IN VETERINARY HYGIENE AND ANIMAL HUSBANDRY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (July 7).

ANALYST (graduate in chemistry or an associate of the R.I.C.) with experience of analytical work, and a PHYSICIST (graduate) for technological investigations on rubber—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey.

ASSISTANT EDUCATIONAL PSYCHOLOGIST (woman, with honours or research degree in psychology, and experience in teaching) to the Child Guidance Clinic and the Bristol schools—The Chief Education Officer, The Council House, College Green, Bristol 1.

ASSISTANT LECTURER AND DEMONSTRATOR IN THE BIOLOGY DEPARTMENT, and an ASSISTANT LECTURER AND DEMONSTRATOR IN THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

ENGINEER at a Ministry of Supply establishment near Sevenoaks, for design and development work in a wide field of electronic instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.115/52A.

ENGINEERS at a Ministry of Supply Research Establishment in Bucks: (Ref. D.119/52A) with a wide experience in radio communications and/or electronic engineering and specialist experience in (*a*) aerial design and propagational characteristics of frequencies above 30 Mc./s. (*b*) pulse transmitters and receivers, (*c*) pulse circuit techniques and display systems, (*d*) radio navigation and approach aids, or (*e*) servo systems and turning gear; (Ref. D.120/52A) with experience in (*a*) pulse type approach aids, including aerial systems, (*b*) telecommunication and navigational aid systems, (*c*) radio telegraph and radio telephone terminal offices and associated radio receiving and transmitting stations, (*d*) transportable ground radio installations, or (*e*) mobile radio and radar equipment, including vehicles, and a sound knowledge embracing modern theory and practice of at least one of the abovementioned systems or equipments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

GRADUATE IN CHEMISTRY or PHYSICS as research assistant in the Chemical Engineering Department—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

GRADUATES IN PHYSICS or MATHEMATICS (with first- or second-class honours) as METEOROLOGICAL OFFICERS in Northern Rhodesia—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27118/14/52.

INSPECTOR OF HORTICULTURE (with a university degree or diploma in horticultfre and/or Kew certificate) for the development of fruit and vegetable cultivation in the Blue Nile Province riverain areas and in Fung District and in Kassala Province—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Horticulture. 4/413'.

LECTURER IN AIRCRAFT MATERIALS—The Head of Aeronautics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

LECTURER IN BIOLOGICAL SUBJECTS (to be responsible for the organization and general supervision of all courses in biological subjects in the College, both day and evening) at the College of Technology and Commerce—The Director of Education, City Hall, Cardiff.

LECTURER IN RUBBER CHEMISTRY—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, Glasgow, C.1.

PHYSICIST for research on the physical properties of materials for use in scientific instruments—The British Scientific Instrument Research Association, Sira, Southill, Chislehurst, Kent.

POWER STATION CHEMIST to the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28340.B.

RESEARCH METALLURGIST (graduate) for work in the Tinplate Section—The Tin Research Institute, Fraser Road, Perivale, Greenford, Middx.

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British Commonwealth Collections of Micro-organisms. Directory of Collections and List of Species maintained in the United Kingdom and Crown Colonies. Pp. iv+59. (London : H.M. Stationery Office, 1951.) 5*s.* net. [151

Chemotherapy of Cancer. The Inaugural Florence Blair Bell Lecture delivered at the Liverpool Medical Institution on 16th November 1950. By Sir Stanford Cade. Pp. 31. (Liverpool : University Press of Liverpool, 1951.) 2*s.* 6*d.* [171

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